TENTH REPORT

OF THE

STATE BOARD OF HEALTH

OF THE

STATE OF MAINE

FOR THE

Two Years Ending December 31, 1897

1896-1897

AUGUSTA
KENNEBEC JOURNAL PRINT
1898.

STATE BOARD OF HEALTH OF MAINE.

OFFICE OF THE SECRETARY,
AUGUSTA, ME., July 27, 1898.

To His Excellency, Llewellyn Powers, Governor, and the Honorable Executive Council:

GENTLEMEN:—I have the honor of submitting to you the Tenth Report of the State Board of Health of Maine, it being the third biennial report and for the years 1896 and 1897.

Very respectfully,

A. G. YOUNG, M. D.,
Secretary.

MEMBERS OF THE BOARD—1896-'97.

CHARLES D. SMITH, M. D. *President,*	Portland.
E. C. JORDAN, C. E.,	Portland.
Prof. F. C. ROBINSON,	Brunswick.
A. R. G. SMITH, M. D.,	North Whitefield.
G. M. WOODCOCK, M. D.,	Bangor.
M. C. WEDGEWOOD, M. D.,	Lewiston.
A. G. YOUNG, M. D., *Secretary,*	Augusta.

CONTENTS.

INTRODUCTORY.

The Tenth Report (the third biennial report) of the State Board of Health herewith presented is for the two years ending December 31, 1897. During this time, as in the preceding years, the chief and the most important work of the Board has been the quiet direction and co-ordination of the public health work in the State. Though unusual epidemic outbreaks have been infrequent, the work of aiding and advising local board of health, and in supplying them with blanks and circulars needed in their work of preventing and restricting diseases, is an ever present one.

The most notable outbreak of infectious disease which occurred within the two years was the epidemic of diphtheria in and around Fort Kent. Through an unfortunate series of local circumstances, the disease was found to be widely extended among the poorer class of people in the outlying parts of Fort Kent and the surrounding plantations, when the representative of the State Board of Health arrived. Nevertheless, the rapidity with which the disease was stamped out under adverse conditions, with the thorough use of quarantine, antitoxin, and disinfection, should encourage other local boards to employ the same efficient measures if occasion should call for them. A narration of the work done in connection with this outbreak may be found elsewhere in this report. A few other outbreaks are briefly referred to.

A large part of this report is devoted to disinfection. A report by Professor Robinson and Mr. Bryant on the second year's work in the study of formaldehyde as a disinfectant is a valuable contribution to the literature of that subject. The preparation of the paper entitled "Notes on Disinfectants and Disinfection" is the outcome of an examination of the results

which have been obtained in the last fifteen years or so in the investigation of disinfecting agents. This somewhat prolonged study was indispensable to putting upon a sound scientific basis the rules of the Board relating to disinfection. "Circular No. 68, Disinfectants and Disinfection," prepared principally for local boards of health and physicians, gives more explicit directions than can be given in the more popular circulars on the various preventable diseases.

SECRETARY'S REPORT.

The names and addresses of the members of the Board at the end of the year 1896, with the dates of expiration of their terms of office were as follows:

C. D. Smith, M. D., Portland, term ending January 31, 1897.

A. R. G. Smith, M. D., North Whitefield, term ending January 31, 1898.

E. C. Jordan, C. E., Portland, term ending January 31, 1899.

M. C. Wedgewood, M. D., term ending January 31, 1900.

Prof. F. C. Robinson, Brunswick, term ending January 31, 1901.

G. M. Woodcock, M. D., Bangor, term ending January 31, 1902.

At the annual meeting in March, Dr. C. D. Smith was unanimously elected President for the ensuing year. The following committees were appointed by the President:

On Finance.—E. C. Jordan, M. C. Wedgewood, and the Secretary.

On Circulars and Other Publications.—A. R. G. Smith, G. M. Woodcock, and the Secretary.

On Sewerage and Drainage and the Disposal of Excreta.—E. C. Jordan, F. C. Robinson, A. R. G. Smith, G. M. Woodcock.

On Ventilation.—M. C. Wedgewood and E. C. Jordan.

On Summer Resorts.—E. C. Jordan, M. C. Wedgewood, and the President.

On Water and Water Supplies.—F. C. Robinson, M. C. Wedgewood, and the Secretary.

On School-Houses and School Hygiene.—F. C. Robinson, G. M. Woodcock, and the Secretary.

On Quarantine.—The President, M. C. Wedgewood, G. M. Woodcock, and the Secretary.

On Legislation.—The Secretary, the President, and M. C. Wedgewood.

On Experimental Work with Low-Cost Steam Disinfectors.—The Secretary and F. C. Robinson.

By special vote of the Board a standing committee on the production and use of vaccine lymph, antitoxin and other inoculation material, consisting of C. D. Smith, was created.

The Secretary submitted a report on a visit to Bar Harbor, December 25, to confer with the local board of health about an outbreak of fever in that town. He also reported concerning a visit to Pittsfield to advise the local board in regard to certain sources of ice supply for use in the village, which were deemed unsuitable by the local board.

The Secretary was authorized to collect information relating to the best methods of disposal of tannery wastes, so as to avoid the production of nuisances, and to visit for that purpose certain places where precipitation or other methods are said to be in use.

The Secretary was also asked to make, at the next meeting of the Board, a presentation of the laws of other states relative to the inspection and control of illuminating oils.

A resolution was passed to the effect that cities and towns be urged to make a careful census at least once in two years and forward the same to the Registrar of Vital Statistics.

At the second quarterly meeting, in accordance with the instructions of the Board at the last meeting, the Secretary read extracts from the laws of other states relating to the inspection and control of illuminating oils, and made brief suggestions, in a general way, for the shaping of a bill for the purpose of regulating the same matter in our own State. The Secretary was instructed to make a draft of a bill, after conferring with the Committee on Legislation, and to submit it to the Board at its next meeting. The Secretary made a verbal report to the Board of the results of his visit to the office of the State Board of Health of Massachusetts; to the Bacteriological Laboratory of the Massachusetts Board; to Stoneham with Dr. Abbott of the Massachusetts Board, for the purpose of examining methods of treating wastes from tanneries; to Sharon to visit the Sanitarium for Consumptives; and to Brighton Abattoir to inspect

the methods of disposing of wastes and of maintaining cleanliness.

In accordance with the request of the Board at the meeting of November 18, 1895, Prof. Robinson has done considerable work for the purpose of determining the disinfecting power of formaldehyde. In the course of this work he has given much thought to the invention and construction of a lamp capable of generating formaldehyde gas rapidly and in large quantities, and at this meeting of the Board he exhibited the latest form of his lamp in operation. Though he made no formal report, his verbal reports relative to the efficacy of formaldehyde gas as a disinfectant were very encouraging. He was authorized at this meeting to do some work for the purpose of determining the practical value of some other disinfecting agents.

At the third quarterly meeting of the Board in October, Prof. Robinson and Dr. Woodcock as delegates of the Board to the annual meeting of the American Public Health Association held at Buffalo, N. Y., reported verbally to the Board on the proceedings at the meeting.

In accordance with the instructions of the Board, the Secretary presented, at this meeting, a draft for a bill providing for the inspection and control of illuminating oils. The discussion which followed made it evident that it was the sense of the members that it would be better to have a law providing in a systematic way for the inspection, not only of illuminating oils, but for the examination of food stuffs to guard against the harm which results from their adulteration. It was voted to lay the whole matter upon the table, including the bill which had been prepared.

The Secretary made brief verbal reports relative to a visit to Winthrop, July 29, to inspect a nuisance caused by the waste water from a creamery; on a visit to Vanceboro, August 18, to consult with the local board of health about the pollution of the St. Croix river at a point above the place from which a large part of the water supply of the village is taken, the source of pollution being a sewer from the hotel owned by the Maine Central Railway, and from the Maine Central Station; and on a visit to North Vassalboro, September 29, to advise the local board of health relative to an outbreak of diphtheria which had occurred in that village.

At the last quarterly meeting of the year, in December, the Secretary reported the proposed action of the local board of health of Westbrook in excluding all cases of tonsilitis from the schools.

By a vote of the Board the Committee on Experimental Work with Low-Cost Steam Disinfectors was discontinued, and in its place the President was required to appoint a committee to be known as a Committee on Disinfection. The members appointed to serve on this committee were F. C. Robinson, C. D. Smith, and the Secretary.

The Board reaffirmed its opinion that the great majority, at least, of cases of membranous croup are diphtheritic; that, without the bacteriological test, it is practically impossible to diagnosticate cases of non-diphtheritic croup from cases of diphtheritic croup, and as the bacteriological diagnosis is rarely available, the Secretary was instructed to advise local boards of health, when occasion requires, to apply the same preventive measures to cases of membranous croup as to cases of diphtheria.

With reference to Senate Bill 1552 which threatens to interfere seriously with the valuable work which is carried on in the laboratories of several of the departments at Washington, the Secretary was instructed to write the following letter to each of our members in Congress:

Dear Sir: I am directed by the State Board of Health of Maine to write to you that, in its opinion, as expressed at its meeting of this date, the passage of Senate Bill 1552, a "bill for the prevention of cruelty to animals in the District of Columbia," would put scientific investigation under so troublesome a system of espionage as to hinder very seriously the progress of biological work of the kind which has already yielded results of inestimable value to the interests of health and life, and promises still more beneficent results in the near future.

A very scant retrospect of the work already achieved must bring to mind what Pasteur and his associates have done in reducing the fatility following the bites of rabid dogs; the remarkable diminution in the death-rate from diphtheria which has followed the use of the anti-diphtheritic serum; the successful treatment of tetanus with a similar antitoxic serum; Haff-

kine's method of protective inoculation against Asiatic cholera, the efficacy of which has lately been confirmed by workers in Koch's laboratory; and more recently the news that Dr. Yersin, a noted pupil of Pasteur, has successfully applied the serum therapy to a series of cases of bubonic plague in Canton, China. Besides this work for the benefit of the human race, many thousands of dollars have been saved to agriculturists by work in similar lines applied to the diseases of animals. An indispensable requisite of most of this work is experimental tests upon animals, experiments, the most of which, are not severely painful.

This work is too valuable to the human race to be put under the stigma of the ban of the law, and to be impeded, as in the opinion of this Board it would be, if laws like that provided in Senate Bill 1552 were in force.

We, therefore, respectfully ask you to use your influence against the passage of this bill. (Signed), A. G. Young, Secretary.

The membership of the Board at the end of the year 1897, with the dates at which the terms of each member expires, is as follows:

A. R. G. Smith, M. D., North Whitefield, term ending January 31, 1898.

E. C. Jordan, C. E., Portland, term ending January 31, 1899.

M. C. Wedgewood, M. D., Lewiston, term ending January 31, 1900.

Prof. F. C. Robinson, Brunswick, term ending January 31, 1901.

G. M. Woodcock, M. D., Bangor, term ending January 31, 1902.

C. D. Smith, M. D., Portland, term ending January 31, 1903.

At the annual meeting in March, Dr. C. D. Smith was again unanimously elected President. The composition of the standing committees remained the same as in the preceding year.

In view of the reported extensive prevalence of small-pox at certain Cuban ports, the Secretary inquired of the President as to the amount of shipping between Cuba and Portland. Dr. Smith stated that there is practically none.

The Secretary was requested to obtain from the Attorney-General an opinion as to the duty of the State Board of Health in enforcing the provisions of Chapter 123, Laws of 1887, particularly those relating to reports from local boards of health to the State Board.

The Secretary in compliance with the request of the Board at the last meeting, having obtained legal advice as to the duties of the Board when local boards of health fail to make such reports or returns as are prescribed in the law, read a letter of instruction from the Attorney-General. In accordance with the advice of the Attorney-General the Secretary of the Board was instructed to proceed against secretaries or health officers of local boards of health who persistently or wilfully fail to report to the State Board.

Some time was spent by the Board in discussing the subject of bovine tuberculosis, the tuberculin test, and what action local boards of health may, or should take in controlling milk supplies. The Secretary was instructed to prepare a resumé of the opinion of the leading authorities on some of the more important questions under consideration. Among them: the effects of the tuberculin test on cows,—whether it is injurious or not,—and, the trustworthiness of the tuberculin test.

At a special meeting of the Board September 22, the Secretary reported on an outbreak of diphtheria in Fort Kent, and on one in Castle Hill, Mapleton, and Presque Isle. A letter from the secretary of Mapleton was read which stated that a man and his wife under quarantine in Castle Hill on account of the presence of diphtheria came to Mapleton visiting. This case had been referred to the Attorney-General. In accordance with the advice of the Attorney-General, the Secretary of the State Board was instructed to advise the prosecution of this man, if the facts appeared to be as they were stated.

The bare possibility of the introduction of yellow fever into some of our ports was considered and rules of action were outlined in view of this possibility.

At the fourth quarterly meeting of the Board in December, the Secretary reported the measures that had been taken in connection with the epidemic of diphtheria in and around Fort Kent,—the sending of instructions and of antitoxin, disinfectants, and formaldehyde generators; the warning of other towns

and plantations, and the demand that a local board be organized in every one of them; the appeal to the Catholic clergymen to use their influence with the people against spreading the infection; and the sending of Dr. W. Johnson to instruct and aid the local board. The Secretary read also the opinion of the Attorney-General on several questions touching the Fort Kent outbreak, which had been submitted to him. The report of Dr. Johnson was presented. It was to the effect that only two convalescing cases remained when he left after less than two weeks' work, although there were about seventy-five cases when he arrived.

The Secretary reported also on his action with reference to the prevalence of diphtheria in Lewiston and Whiting, and made a final report on diphtheria in Castle Hill and Mapleton.

Dr. C. D. Smith as standing committee of the Board on antitoxin and vaccine material made a report to the Board on his inspection of the antitoxin establishment of Mulford and Co., of Philadelphia, and that of Parke, Davis and Co., of Detroit. The opinion of the doctor is that the methods pursued in both establishments are careful and trustworthy and that the product of these two houses should now be preferred for use in this country.

DIPHTHERIA IN THE MADAWASKA REGION.

October, 1897, a request was received in the office of the Secretary from the local board of health of Fort Kent, asking that a man be sent to help them in an outbreak of diphtheria which had prevailed some weeks. Although the local board had received detailed instructions, antitoxin, antitoxin syringe, formaldehyde generator, wood alcohol to be used in it, they had, on account of some local misunderstandings and some special difficulties, failed to control the epidemic. Dr. Wellington Johnson of Augusta was, therefore, sent to aid the local board. In addition to verbal advice, the typewritten instructions relating to quarantine and disinfection which he carried and under which he worked were as follows:

Isolation.

1. If the house is small, the well members of the family should be removed from it, as soon as possible, particularly the children.

2. Leave the parents to care for the sick ones, or one parent and a nurse.

3. For nurses obtain persons 40 years of age or older, so far as possible.

4. The well persons removed from the house may be lodged in some neighbor's house if one is available, when this can be done without danger of carrying contagion to the neighboring house.

5. When the disease is found in two or more houses in the same neighborhood, arrange, if possible, to put all the sick in one or two houses. Then disinfect, speedily and thoroughly, the houses from which cases have been removed, and keep the well persons in them.

6. A still better arrangement is: Houses for the sick, houses for the well, and houses for suspects. Suspects should include those with sore throats possibly diphtheritic. As soon as a diagnosis of diphtheria can be made, the suspects should be transferred to the house in which the diphtheria cases are lodged.

7. When the arrangement indicated in 4, 5, and 6 is impracticable, the sick and suspects should be removed to temporary camps or tents.

8. All well persons thus isolated should be disinfected as soon as practicable after they are removed from houses in which there are cases

of diphtheria. Besides the disinfection of their clothing, their hands, hair, and beard should be washed with a disinfecting solution.

9. The elder persons among those who have been isolated on account of exposure to the infection may be employed as assistants in such work as needs to be done,—as cooks for the well and the sick, as messengers between the sick and the well, and as assistants in the disinfecting work, so far as this can safely be done.

10. Persons who have been exposed to the infection, but have shown no symptoms of diphtheria should be isolated one week. Persons who have had diphtheria in any form should remain isolated four weeks, at least.

11. Allow the well persons who are isolated as much liberty upon the premises or in the immediate neighborhood as is compatible with safety. After they have been disinfected as in 8, the permissible degree of liberty may be greater, particularly for adults who have outdoor work to do. They must, however, remain under medical observation seven days, at least, from last exposure.

Disinfection.

12. The work of disinfection should begin with the beginning of the treatment of cases and should continue during the whole course of the disease. All articles of bed clothing and of body clothing should be disinfected as soon as they are removed from the bed or from the patient.

13. Steam disinfection or disinfection by boiling should be employed so far as these methods are applicable and practicable. Boiling one-half hour will disinfect any article that can be subjected to it. Steam disinfection, properly done, is just as trustworthy, and has the advantage of wetting the goods less.

14. A steam disinfector may be ordered as follows at a tinman's:—Make it like a common tin wash boiler, only have it 22 inches square, or made with rounded corners, and 30 inches high. Upon the sides, five inches from the bottom, have brackets attached for the support of a false bottom. This false bottom may be made of heavy galvanized iron perforated with ten or twelve half-inch holes. It should be supported in the middle by a cradle made of galvanized iron wire, or galvanized iron plate, removable for convenience when wiping and drying the bottom. The side brackets for the support of this false bottom should be attached with rivets, so they will not come off if the heat strikes them above the surface of the water, as they might possibly, if used over an open fire outdoors. The part of this steam disinfector beneath the false flooring must be perfectly water-tight; slight leaks in the part above, which is to be filled with steam, are of not so much consequence. Two strong handles should be placed 18 inches from the bottom on opposite sides. Have two half-inch holes in the cover for the escape of steam.

15. When using this steam disinfector put three or four inches of water into it, put in the false bottom, and above that pack in rather

loosely the clothing to be disinfected; put the cover on tightly and steam one hour after the water begins to boil, keeping the water briskly boiling all the time. Many kinds of clothing that would be injured by boiling can be disinfected in this way without injury.

16. After the steaming, the apparatus should be carried into the open air immediately, and the clothing should be thrown over a line. Usually clothing thus treated is not very wet, and will dry in a few moments if spread out in the open air while hot.

17. If you should have this apparatus made of galvanized iron, you would need to have it lined on the inside with thin strips of wood, or with cloth, to keep the clothing from coming in contact with the iron. You can use the apparatus, in most cases, upon the cooking stove, taking off the four covers.

18. Steam disinfection on a small scale can be done in the common tin wash boiler, by supporting, above the water with two bricks or otherwise, a false flooring of laths or thin boards.

19. *Formaldehyde.*—When the matter to be disinfected is open (well exposed to the gas) formaldehyde gas is much more efficient than the fumes of sulphur. Formaldehyde, also, has a somewhat greater power of penetration than sulphurous acid. It will not, however, be safe to trust to formaldehyde to penetrate deeply into clothing. It may be used very conveniently and efficiently for the disinfection of infected rooms, furniture, or other infected surfaces, at no matter what height in the room.

20. In the disinfection of rooms with formaldehyde gas, the rooms must be flooded with the gas quickly. To disinfect thoroughly 2000 cubic feet of room space, at least a quart of wood alcohol should be changed to aldehyde within an hour and a half. The room should be made as close as possible and should be kept closed for from four to six hours.

21. For the suitable penetration and disinfection of clothing and bedding, they should be treated separately in a small close room or closet, or, if in a large room, at least two quarts of wood alcohol should be used for 2000 cubic feet of room space, and the room should be kept closed not less than six hours. Clothing, when exposed to formaldehyde must be well exposed, preferably over lines. Steam, however, at 212° F. is more trustworthy, for its greater power of penetration. (See 14 to 18.)

22. The disinfection work to be carried out in conformity with the following rules, as far as possible. No bedding or other property to be burned or otherwise destroyed if it can be avoided.

23. *Cotton and Linen Clothing.*—Disinfect so far as possible with steam or by boiling. Or disinfection may be done by immersion in 5 per cent. solution of carbolic acid or lysol (7 ounces of carbolic acid or lysol to 1 gallon of water), or in solution of corrosive sublimate 1:1000 (1 dram of corrosive sublimate in 1 gallon of water). The clothing should remain in the solution ten or twelve hours at least. (Solutions of corrosive sublimate to be kept in glass or wooden containers, never in metal.)

24. In transporting clothing from the sick room for steam disinfection or boiling, wrap it in a sheet wet in one of the solutions mentioned in 23, or, in absence of these, in water. As an alternative, the steam disinfector or boiler may be carried into the sick room and there filled. When one of the disinfecting solutions is to be used, it should be kept in a wooden tub in the sick room or near its door.

25. *Woolen Clothing.*—Disinfect with steam or solutions under 23.

26. *Bedding.*—Throw straw-beds out of window. Empty out and burn straw. Then disinfect the tick as in 23. Disinfect feather beds, pillows, quilts, comforters, and blankets in steam disinfector. Require local board to burn cheap mattresses that cannot be disinfected otherwise.

27. *Boots and other Leather Articles.*—Wash in one of solutions in 23, or expose to formaldehyde.

28. *Rugs and Carpets.*—Disinfect with steam, or, if of very slight value, the local board is to burn. For the disinfection of a carpet in the sick room, where it may have received infectious sputa, formaldehyde should not be trusted. In other rooms, it may be, but steam is preferable.

29. *Lounges, Couches, and Other Upholstered Furniture.*—Leave in place when the room is disinfected with formaldehyde. Then if of value, wash thoroughly with corrosive sublimate solution. Then carry outdoors and expose to direct sunshine as long as possible. If of little value, strip off and disinfect the covering as in 23. Burn worthless filling.

30. *Excreta.*—Use "milk of lime" for privy vaults, prepared from caustic lime just as whitewash is made, only thin it out rather more. Saturate contents of vault, and ground beneath.

31. *Sputum.*—To be received on pieces of rag or paper and burned. Before disinfecting room with formaldehyde, wash up or moisten any parts of floor, walls, or furniture soiled with discharges from nose or mouth.

32. *Corpses.*—Wrap in sheet wet in corrosive sublimate solution, and bury as speedily as possible.

33. *Mouth and Throat of Nurses and Attendants as a Prophylactic.*—Rinse in a 1 per cent. solution of formalin, or five drops of formalin in one ounce of water. (Formalin and 40 per cent. solution of formaldehyde are the same.)

34. *Clothing of Nurses and Physicians.*—Steam is preferable. For physician's suit, two or three ounces of formalin poured on rag beside suit in tin wash boiler or tight box of about same size. Close tightly. Leave over night. Cannot be worn until well aired.

In addition to isolation and disinfection, diphtheria antitoxin was freely used for its curative and immunizing effects. The surrounding towns and plantations were warned early to have their public health organizations ready to look out for any cases

that might be introduced into their respective jurisdictions. The selectmen of one town, who in defiance with the requirements of the law, had failed to appoint a local board of health, received an ultimatum, the result of which was the organization of a local board of health after diphtheria had spread considerably. In response to a personal letter addressed to each, the Catholic clergymen cordially coöperated with the local boards and the State Board. The Secretaries of the Provincial Board of Health of New Brunswick and of Quebec were notified of the outbreak, and arrangements were made for coöperation, if necessary. The final report of Dr. Johnson's was as follows:

To the State Board of Health,
A. G. Young, M. D., Secretary,
Augusta, Maine:

On the afternoon of October 9, 1897, I was asked by Dr. A. G. Young, Secretary of the State Board of Health, to go to Fort Kent to see what could be done to stamp out an epidemic of diphtheria which had grown from a few cases to so alarming an extent that more than a hundred individuals had suffered from the dread disease, and there had already been twenty-five deaths. Unfortunately the local board of health had lost control of the epidemic, and a few days previously had sent to the State board for assistance.

According to arrangements I started on the 2 A. M. train Monday morning, and arrived at Caribou at 2.30 P. M., where I took a team for a drive of forty-two miles which was covered that night. Thus I arrived at Fort Kent 10 P. M. of the same day I left home. Word had reached there that relief was to be sent from Augusta, and your correspondent received a hearty welcome from all except the hotel proprietor, who was afraid to have him in the house after he had been visiting diphtheria cases all day.

After a night's rest, working under Dr. Young's instructions, I started out early in the morning to learn the true status of what had to be done to get full control of the epidemic. The local board, composed of A. G. Fenlason, I. B. Bourgoin, and Dr. F. G. Sirois, together with the chairman of the board of selectmen, V. A. Therriault, and the Catholic priest, Father F. X. Burque, were all disposed to render all the assistance they could in bringing about a speedy relief from the spread of the now dreaded disease.

Word had gone forth to the outside world of the present state of affairs at the Fort, so that business was being paralyzed, traveling men not daring to come into the town, so much so that stringent measures must be undertaken to change matters for the better protection of all concerned.

Upon inquiry, I found that the Health Officer, Dr. Sirois, had been trying to manage the whole affair alone, but was fast losing ground as the disease was spreading to other localities; being carried from place to place by those who were not disposed to obey quarantine laws and regulations, and thus crippling the local board in its efforts to stamp out the disease. Active measures were taken and the arrest of one renegade had a salutary effect on the would-be travellers who had been exposed to the disease. Dr. Sirois not being able to care for all the sick, Dr. J. F. Archambault was invited to take part in the warfare against the Klebs-Loeffler Bacillus. Accordingly on Tuesday morning, October 12, the above named physician, with I. B. Bourgoin, member of the board of health, and myself, started on a raid armed with antitoxin and antitoxin syringes. Our first day's campaign was rewarded by finding thirty cases of diphtheria, and antitoxin was administered to all without any serious objection on their part.

The next day found the same party on a similar errand and this was continued until we made the rounds and seventy-five or eighty cases were treated. Strange to say, out of the first seventy cases in that vicinity, there were twenty-five deaths, while in the last seventy-five cases treated by antitoxin only one died that received the treatment, and that was a child of twelve years, who had been sick ten days. A glorious record for the new method of treating the disease with antitoxin.

As to details of treatment: As soon as a case was found we immediately gave from 500 to 1,500 units injected into the deep tissues of the abdomen, the dose varying according to the age of the patient and the severity of the disease. In twenty-four or thirty-six hours, the throat would clear up, temperature and pulse would become normal, and the patient would be on the road to recovery. We also used boric acid solutions for gargle, and tincture of muriate of iron and quinine internally. As soon as all the members of the family became convalescent, a thorough disinfection was done with Prof. Robinson's formaldehyde generator, and the steam arrangement for clothing, pillows, etc.

Results: In two weeks' time there were only two cases in the several towns and plantations, and these convalescent. So much for active, persistent, and thorough work with the proper implements to fight the diphtheria germ. The serums used were Messrs. Parke, Davis & Co's., and Pasteur's.

In addition to the medical treatment and the disinfection, local boards were organized in the plantations of New Canada, Wallagrass, and the town of Frenchville, and instructed how to proceed in the prevention and cure of contagious diseases, especially diphtheria. Take it all in all, a busy two weeks' work was accomplished by the representative who was sent there by Dr. Young under the auspices of the State Board of Health, for he met and held meetings with the local boards nearly every

evening. Great praise is given the State Board by the local boards and citizens, for the ready response the State Board made in the hour of need.

Wellington Johnson.

Augusta, October 30, 1897.

The portable steam disinfector made in accordance with the instructions which have been given, with the exception that it was round instead of square, was of great help in the disinfection of clothing and bedding.

Mr. Isidore Bourgoin, as a member of the local board of health, was with Dr. Johnson and the Health Officer of the board most of the time and supervised the work of disinfection with formaldehyde, steaming, and otherwise. After the return of Dr. Johnson, arrangements were made with Mr. Bourgoin to instruct and help the local boards in any of the surrounding towns or plantations in the work of disinfection, if any of them should need help. Subsequent events showed that his services were needed, and in the final extinction of the epidemic he did efficient work.

DIPHTHERIA IN CASTLE HILL AND MAPLETON.

Though the outbreak of diphtheria in these two adjoining towns did not become a very extensive one, the failure of a prompt diagnosis in the earlier cases, and the resulting absence of disinfection, were the cause of recurring infections, and unnecessary prevalence of the disease and several deaths. Though the testimony is conflicting, the origin of the outbreak appears to be as follows;

A young lady came from Boston to Portland with sore throat. She went to house No. 1. Three days later a boy in this house was attacked with diphtheria. Some of the members of the family and this young lady were sent to house No. 2. Soon after two children developed sore throat in house No. 2. The young lady from Boston then went to her home in Castle Hill. June 1, or three days after she reached home, her sister was attacked with a sore throat and died June 17. The cause of death, given under the death certificate, was "heart failure." A brother came down with the disease June 8, recovered from the primary attack but succumbed to the sequels later. This appears to have been the starting point of the outbreak, though it has been referred to cases which occurred still earlier, and which were not recognized as diphtheria, and in which isolation and disinfection were neglected.

When the gravity of the situation in these two towns was recognized by the State Board, Dr. Frank Kilburn, Health Officer of Presque Isle, was asked to advise and help the local board in these two towns. Under instructions similar to those which were afterwards sent to Fort Kent, the outbreak was stamped out. The chief value of a recital of the incidents of this outbreak lies in the fact that it may illustrate some points relating to the powers and duties of local boards of health, and some rules of action for local boards.

Quarantine—Powers of Local Boards.—A man and his wife who were quarantined in Castle Hill, disregarding the requirements of the quarantine, went to Mapleton on a visit. In answer to the communication of this fact, the secretary of Mapleton was instructed to send the name of the man, and: "If you have such a case again, have the man arrested at once. I am laying the matter before the Attorney General, and will instruct you more definitely in regard to this case. From what you write it would seem that an example should be made of him, for by his action he wilfully endangered the public."

The secretary of the local board of health of Mapleton gave the man five minutes to go home or to be arrested, and he went. The instructions from the Attorney General were as follows:

"There have never been any tests made of the strength of the contagious disease statutes which we have, and the sooner we commence a row the sooner the State will be relieved of such criminal carelessness as you refer to in the case at Castle Hill. I have no doubt but that the statute will be upheld by the court to the extent of punishing those who violate the clear provisions of it.

"I also have no doubt that it is the duty of the county attorney to investigate and institute prosecutions against any violators of the provisions of the contagious disease law which may occur in his county; and I think it is your duty to call upon the county attorneys to prosecute any such cases. After you have made one or two examples, there will be no trouble about the enforcement of these statutes.

"In regard to the expense of prosecution: That is a matter that the county attorney should take care of. Misdemeanors are as much within his jurisdiction as crimes, and it is as much the duty of the county to pay the expenses of their prosecution as it would be of larceny.

"In regard to the man at Castle Hill: I should say he should be arrested wherever found by the officer who had jurisdiction to arrest him where he found him, to wit, the sheriff of the county and by the constable of the town in pursuit of the prisoner or the party complained against. It is a very simple matter to have a warrant issued and placed in officer's hands for service, and is a much safer way to proceed than without it,

although I have no doubt in a case such as you speak of that the doctrine as laid down by Parker and Worthington in "Public Health and Safety" would be good law, but you know it is always a question of fact on summary proceedings whether or not the conditions of things warrant such process. I have no doubt a health officer would be authorized in such a case as you report to call on the sheriff or constable to make immediate arrest without a warrant, and the constable or sheriff would be authorized in making such arrest and taking the party back to the place of quarantine, and placing guard over him if necessary to keep him there. But a better method would be to have an arrest on warrant, tried and fined.

"It will never be necessary to carry through more than one case of this kind in a county, and probably a case carried through in one county would be sufficient for the whole State.

"I should recommend that local boards of health turn their cases over immediately to the county attorney, and that you so advise them; also that you urge county attorneys to act promptly; and if they do not act promptly I would like to have you report them to me, and I will see what I can do toward accomplishing results."

Disinfection of Letters.—The following letter is self explanatory:

"Yesterday I received a letter from the postmaster of Presque Isle, expressing some apprehension as to the danger of diphtheria infection in the mail matter which comes from your town. He stated that some of the mail matter smelled of carbolic acid. I would suggest that you instruct the postmaster of your town what to do with regard to letters, or other mail matter which comes from infected houses in your town. I herewith enclose a copy of the United States postal law relative to such cases. The best way for you to disinfect the pieces of mail matter coming from infected houses, is to put them into a small tight box, or any kind of a dish that can be covered over very tightly, and in with the letters, put a piece of sponge or an old soft, cotton cloth wet with, say a tablespoonful of solution of formaldehyde, or formalin is another name under which it goes. Cover the letter, or other matter over tightly, and leave it exposed to

the formaldehyde vapor five or six hours, at least. It would be better to have the letters disinfected before they are sealed.

"A tablespoonful of formaldehyde solution would do for a box six inches square, say. The smaller the enclosed space in which the letters are put, the more concentrated, of course, would be the gas.

United States Postal Laws Relating to Infectious Diseases.—Section 667 of the United States Postal Laws, to which reference is made in the foregoing, reads as follows:

"1. A postmaster should refuse to receive into his office mail matter brought to it by persons who are inmates of, or messengers from houses containing cases of contagious diseases, such as small-pox, yellow fever, etc., when ordered to do so by a board of health, or other local authority having jurisdiction of matters affecting the public health. If there be no such organization or official, the postmaster should be governed by the advice of one or more reputable physicians.

"2. Mail matter arriving at an office addressed to the inmates of such houses may be sent to them by the hands of some responsible person known to the postmaster.

"3. When a board of health serve upon a postmaster a certified copy of a declaration or order duly made that mail matter from any other post-office is liable to communicate a contagious disease prevailing at the time, he should refuse to receive such mail matter from any carrier or messenger, but will deliver to the carrier or messenger a copy of such order or declaration and will report the facts at once to the First Assistant Postmaster General. If there be no board of health the same action may be taken by the postmaster upon the declaration of a regular county or city medical society, or, if there be none, upon the advice of a physician reputable in his profession. The mail so returned shall be held until the prohibition is removed, and shall, after being properly fumigated under the directions of the medical authorities, be dispatched to its destination.

"4. If a case of small-pox, yellow fever, or other contagious disease occurs in the family of a postmaster occupying the building in which the post-office is kept the postmaster should notify his sureties to take possession of the office and conduct it temporarily elsewhere until the danger of contagion is passed."

NEW CIRCULARS AND NEW EDITIONS.

A new circular on disinfection and new and revised editions of some of the older circulars, issued before this report was sent to the printer, are here presented.

Circular No. 68.

STATE BOARD OF HEALTH OF MAINE.

DISINFECTANTS AND DISINFECTION.

Any circular on disinfection should necessarily be considered as only provisional. Modern scientific methods are constantly adding to our accumulation of those facts which help us to destroy disease germs with greater certainty. Our knowledge of the relative activities of the various disinfecting agents and of their applicability to special purposes has in recent years been so widely extended that there has been a great gain in the certainty of results in disinfecting work,—at least so far as the recent additions to our exact knowledge of disinfecting agents are put to practical use.

One great obstacle to improvement in methods is the influence of old traditions. Many agents formerly in repute are now known to have but little value as real disinfectants. (See "Disinfectants, Real and False.")

A disinfectant is an agent which may be used for the destruction of disease germs. A disinfectant is then a germicide. A deodorant is something capable of removing disagreeable smells. Some deodorants are also trustworthy disinfectants, and some are not; while, on the other hand, some disinfectants are very efficient deodorants, and others have less value in this direction.

In disinfecting work, therefore, the distinction between disinfection and deodorization should be kept strictly in view, and agents and processes should be employed which, by the more exact methods of modern times, have been proved to be efficient destroyers of infection.

The observance of this reasonable rule will exclude the use of some "time honored" disinfectants and many patent, or proprietary preparations. As regards the latter generally, they may well be replaced by solutions which may be prepared under the direction of any druggist, physician, or experienced health officer, and which are more economical and of known efficiency. The sale of some of the old nostrums is still bolstered up by testimonials or favorable words uttered before exact methods of testing them were known.

DISINFECTANTS, REAL AND FALSE.

Carbolic Acid.—Although not one of the most rapidly acting disinfectants, this has been one of the most useful. Some other agents are preferable when the time for disinfection is necessarily brief. When it can have ample time to act, its action, as well as that of the cresol preparations, is continuous; for, in exerting its disinfectant power, it is not itself decomposed by organic matter, as is the case with the oxidizing agents,—chloride of lime, permanganate of potassium, etc. Its action is unimpaired by the presence of acids, alkalies, salts, or albuminous material. The activity of its solutions is increased by the addition of common salt. Solutions are also more effective when warm or hot. Dissolved in alcohol, oil, or glycerine, carbolic acid loses nearly all its disinfectant qualities. The dangerously poisonous nature of carbolic acid indicates the necessity of precaution against accidents by swallowing, or by too extensive applications to the human body.

Crude Carbolic Acid.—Crude carbolic acid is only slightly soluble in water, but a 3 per cent. solution of soap in hot water dissolves up to 5 per cent. of carbolic acid and forms an effective disinfecting solution for many purposes. The disinfectant properties of crude carbolic acid are due principally to the presence of cresol.

Cresols.—These are derived from crude carbolic acid by distillation. They are somewhat more efficient than pure carbolic acid. The cresols are but sparingly soluble in water. Various expedients have been resorted to for increasing their solubility, some of which are indicated in the following paragraphs.

Lysol.—This preparation contains about 50 per cent. of cresol rendered soluble with neutral potash soap. It forms clear solutions with water in any proportion, and thus has an advantage over carbolic acid for some purposes. Comparing lysol otherwise with carbolic acid, it is found that its solutions are somewhat cheaper than those of pure carbolic acid, that they are somewhat more efficient, that they are more likely to injure the colors of fabrics, and they are a little less poisonous than solutions of carbolic acid. Lysol is superior to carbolic acid for the disinfection of excreta, and in work of this kind it is a good deodorant. In the disinfection of tuberculous sputum it is more efficient than carbolic acid as it dissolves and penetrates albuminous masses more rapidly. Its solutions may be used for washing floors, woodwork, etc., and for the disinfection of linen and cotton clothing by soaking in the solutions.

Tricresol.—Is a mixture of the three cresols,—o-m-and p-cresol. It is soluble in water to about 2½ per cent. only, is more efficient than carbolic acid, and is somewhat less toxic.

Solutol.—It contains 60 per cent. of cresol rendered soluble with cresol-alkali. It is intended for gross disinfection. The results obtained by most of the investigators indicate that it is very efficient, considerably more so than carbolic acid or lysol. It penetrates organic matter and is well adapted for gross disinfection, particularly crude solutol which is cheap and effective. For general use half a pint of the solution may be mixed with two or three gallons of water.

Creolin.—Its active constituents are the cresols emulsified in a solution of hard soap. The English creolin (Pearson's) contains about 10 per cent. of the cresols. With water a dirty white mixture results. It is a good deodorant and a fairly good disinfectant for fecal matter. The usual strength of its solutions is from 2 to 5 per cent. Little's Soluble Phenyle is probably about the same thing.

Corrosive Sublimate.—Under favorable conditions a rapidly acting disinfectant; but it coagulates albuminous matter and is decomposed by hydrogen sulphide and various other materials. It is, therefore, unsuitable for the disinfection of tuberculous or other sputa, or of excreta. Other disadvantages are that its solutions must be prepared and kept in glass or earthenware, that they will destroy metallic waste-pipes, and that they are very poisonous if swallowed.

The rational use of solutions of corrosive sublimate as a disinfectant is, therefore, restricted to the disinfection of walls, floors, the wood finish of furniture, upholstered furniture, clothing which must be treated with disinfecting solutions, and the personal disinfection of hands, hair, beard, and face. The colors of most fabrics are unaffected by them.

Lime.—In the form of lime-wash or "milk of lime" is a good disinfectant for excreta, but it should be used in large quantity and must have ample time to act. Lime may also be used for the destruction of other offensive organic matter, and the disinfection of walls and other surfaces that will admit of such treatment.

Chloride of Lime.—Is one of the best of disinfectants and may be used for the same purposes as lime. The quantity of its solution used must be in excess of that of the material to be disinfected. Chloride of lime should come from a trustworthy source, should be preserved in hermetically sealed packets, and its solutions should be freshly prepared.

Soap—Potash and Soda.—Soap and water may be used not only for cleansing, but when as hot as can be borne by the hand or hotter, soap and water or solutions of washing soda have considerable disinfecting power. The discharges from the bowels, or tuberculous sputum may be disinfected with hot lye, 1 part of hard-wood ashes to 2 of water.

Permanganate of Potassium.—This cannot be classed with the disinfecting agents which act with the greatest rapidity and certainty. In general disinfection it has no place, but it is used for some special purposes.

Sulphate of Copper. (*Blue Vitriol*).—This is a good disinfectant, but the range of its applicability is limited. It may be

used for the disinfection of excreta,—1 or 2 per cent. solutions, —but other trustworthy disinfectants are cheaper.

Sulphate of Iron. (*Copperas*).—This was formerly in use, but it is now known to be worthless as a disinfectant. As a deodorant it is also inferior to some other agents.

Sulphate of Zinc.—This has been shown to have no practical value as a disinfectant.

Chloride of Zinc.—Has some power in restraining the growth of bacteria, but as a real disinfectant it is practically without value.

Gaseous Disinfection.—The idea that the whole work of disinfecting rooms and their contents may be done by the liberation of some disinfecting gas or fumes is a visionary one. It should satisfy only where the work is entirely perfunctory. But gaseous disinfection, particularly the use of formaldehyde, may be regarded as a valuable auxiliary.

Sulphur Fumigation.—It has been shown again and again that, by means of sulphur fumigation, the destruction of disease germs is uncertain or impossible under the conditions in actual practice. When the material to be disinfected is damp and is enclosed in gas-tight rooms, the gas has some disinfecting action; but ordinary rooms cannot be made gas-tight, and sulphur fumes seriously injure many articles when they are damp. The gas is dangerously poisonous when much of it is inhaled. It escapes from rooms readily and a little in adjoining rooms renders them uninhabitable.

For these various reasons the State Board of Health omits sulphur fumigation from the list of disinfecting processes which are recommended.

Chlorine Gas.—Chlorine gas is a more efficient disinfectant than the fumes of sulphur, but it is too destructive to the articles subjected to it to be recommended for general use.

Bromine.—Bromine gas is still more destructive than chlorine, and the disagreeable and dangerous character of liquid bromine renders it unsuitable for the hands of the public.

Formaldehyde.—The experiments made with it in the past few years and the succeeding practical experience in disinfecting work, have shown that formaldehyde gas has advantages over sulphur fumigation or any other gaseous agent. Com-

pared with sulphur, formaldehyde is a more efficient germicide, it is not poisonous, its odor is not so disagreeable, it does not escape from rooms so rapidly as sulphur dioxide, and it has a somewhat greater power of penetration. In ordinary room disinfection it should not be expected to act further than as a surface disinfectant. In small rooms or disinfecting chambers practically gas-tight, with the pieces to be disinfected well separated from each other and with large quantities of formaldehyde, the penetration of the gas is facilitated, and clothing, bedding, etc., may be disinfected with some degree of certainty.

In the disinfection of rooms with formaldehyde, fireplaces, ventilating flues, and other openings must be closed. The rooms should otherwise be made as tight as possible and then they should be flooded quickly. When formaldehyde lamps are used, a pint and a half of wood alcohol to each 1,000 cubic feet of space should be changed to formaldehyde within an hour and a half, and the rooms should be kept closed eight hours or longer.

In the forms of apparatus which volatilize the 40 per cent. solution of formaldehyde, 250 cubic centimetres for each 1,000 cubic feet should be used, and the rooms should be kept closed for the same length of time. Formaldehyde obtained by the volatilization of paraform is just as effective, but costs more. In small enclosed spaces 2 grams should be used for each cubic mefre of space, or 30 grains to each 35 cubic feet.

Various uses may be made of solutions of formaldehyde. A 2 per cent. solution (Solution 7) may be used for washing infected surfaces, or for the disinfection of clothing or other articles that may be immersed in it. In gas-tight caskets or other small enclosures, articles may be disinfected by pouring in with them upon a cloth to absorb it, formalin, or a mixture of formalin, 1 part; wood alcohol, 1 part; and water, 2 parts. The requisite quantity of formalin is 1 ounce to each cubic foot. Clothing may be disinfected by spraying or sprinkling with solution of formaldehyde and then wrapping it in oilcloth or a rubber blanket. Formalin is the proprietary name of the 40 per cent. solution of formaldehyde, which can be more cheaply bought under the name of solution of formaldehyde as put up by some reputable American manufacturers.

Disinfection with Physical Agencies.—A large part of the work of disinfection can and should be done with heat (boiling and steam) as certain, economical, and almost always available, and with sunshine as an auxiliary.

Dry Heat, exemplified in the hot air disinfectors, is untrustworthy and is now but little used.

Boiling for half an hour is a sure way of disinfecting cotton or linen clothing or anything else that can be subjected to this process. Infected material and infected things generally are disinfected more quickly by boiling than with steam disinfection.

Steam Disinfection.—Steam disinfection has the advantage of wetting the goods less than boiling. The mistaken notion is too prevalent that pressure steam is essential to success in steam disinfection. The saving of time is an advantage of using steam under pressure, but for small places the cost of pressure steam apparatus is out of the question. Effective work can be done with flowing steam not under pressure, and in quite cheap disinfectors. The main requisite is an abundance of live steam streaming through the disinfecting chamber and the enclosed clothing or bedding.

When steam at a pressure of from 5 to 40 pounds is available at a factory or other source, it may be carried into a stationary disinfecting chamber which can be built at small cost. The State Board of Health will be glad to advise local boards who are interested in this direction.

A portable steam disinfector may be ordered as follows at a tinman's: Make it of galvanized iron plate like a common tin wash boiler, only have it 22 inches square and 30 inches high. Upon the sides, five inches from the bottom, have brackets attached for the support of a false bottom. This false bottom may be made of heavy galvanized iron perforated with ten or twelve half-inch holes. It should be supported in the middle by a cradle made of galvanized iron wire, or galvanized iron plate, removable for convenience when wiping and drying the bottom. The side brackets for the support of this false bottom should be attached with rivets, so they will not come off if the heat strikes them above the surface of the water, as they might possibly, if used over an open fire outdoors. The part of this

steam disinfector beneath the false flooring must be perfectly water-tight; slight leaks in the part above, which is to be filled with steam, are of not so much consequence. Two strong handles should be placed 18 inches from the bottom on opposite sides. Have two half-inch holes in the cover for the escape of steam.

When using this steam disinfector put three inches of water into it, put in the false bottom, and above that pack in rather loosely the clothing to be disinfected; put the cover on tightly and steam one hour after the water begins to boil, keeping the water briskly boiling all the time. Many kinds of clothing that would be injured by boiling can be disinfected in this way without injury.

After the steaming, the apparatus should be carried into the open air immediately, and the clothing should be thrown over a line. Usually clothing thus treated is not very wet, and will dry in a few moments if spread out in the open air while hot.

This apparatus can be used in most cases upon the cooking stove, taking off four covers. If in cold weather it is used outdoors or in an open room, steam would be wasted by the rapid condensation upon the walls and the disinfection might be a failure. An abundance of steam must stream through the disinfector the whole hour.

Steam disinfection on a small scale can be done in the common tin wash boiler by supporting a false bottom or floor of laths or thin board above the water with two bricks or otherwise.

Sunshine.—Most disease germs are killed by the action of direct sunshine, but as diffused light acts slowly and not with certainty, this disinfecting agency is limited in its applicability. The complete disinfection of rooms and their contents cannot be attained by the admission of sunlight even when aided by thorough airing. About the only practical use that can be made of sunlight in the work of disinfection is the carrying of upholstered furniture and sometimes other things out into the direct sunshine for several days after they have been otherwise disinfected as thoroughly as possible, and a doubt still lingers as to the completeness of their disinfection. It must be remembered that the sunshine must reach all their parts and that the action of light penetrates but little beneath their surfaces.

DISINFECTING SOLUTIONS.

SOLUTION 1. For clothing, woodwork, floors, leather, excreta in the sick-room, sputum, the hands, the person.

SOLUTION 2. For the same general uses as Solution 1. It is a little more efficient than Solution 1; but more likely to injure colors.

SOLUTION 3. For tuberculous sputum, discharges in the sick-room.

SOLUTION 4. For excreta, privy vaults, cesspools, etc.

SOLUTION 5. For the same purposes as Solution 4.

SOLUTION 6. For clothing, the hands, and the surfaces of walls, floors, furniture, etc.

SOLUTION 7. For clothing, the hands, etc.

SOLUTION 1.

Carbolic Acid (pure liquified),	7 ounces.
Water,	1 gallon.

Mix. This is approximately a 5 per cent. solution. Its power is somewhat increased by the addition of from 12 to 14 ounces of common salt to each gallon when used for the disinfection of excreta, or for other uses where the salt is not objectionable.

For the disinfection of clothing this solution mixed half and half with water will do.

SOLUTION 2.

Lysol,	5 ounces.
Water,	1 gallon.

Mix. This may be used as a substitute for Solution 1, one-half the strength sufficing for uncolored clothing. Many colors are changed by it.

SOLUTION 3.

Solutol (crude or pure),	1-2 pint.
Water,	2 or 3 gallons.

Mix. This is a very efficient disinfectant for excreta, tuberculous sputum, and gross disinfection generally. If to be used in dwelling houses, or wherever the odor of the crude product would be offensive, pure solutol should be used.

SOLUTION 4.

Chloride of Lime,	6 ounces.
Water,	1 gallon.

Mix. This is about a 3 per cent. solution. (Decolorizes and destroys fabrics).

SOLUTION 5. "Milk of Lime."

Slake a quart of freshly burnt lime in small pieces with three-fourths of a quart of water,—or to be exact, 60 parts of water by weight with 100 of lime. A dry powder of slaked lime (hydrate of lime) results. Make milk of lime not long before it is to be used by mixing 1 quart of this dry hydrate of lime with 4 quarts of water.

Air-slaked lime is worthless. The dry hydrate may be preserved some time if is enclosed in an air-tight container. Milk of lime should be freshly prepared, but may be kept a few days if it is closely stoppered.

SOLUTION 6.

Corrosive Sublimate,	1 dram.
Water,	1 gallon.

Mix and dissolve. Label, *Poison!* This is approximately a 1:1000 solution. One ounce of this solution contains very nearly half a grain of corrosive sublimate.

SOLUTION 7.

Solution of Formaldehyde (Formalin),	6 ounces.
Water,	1 gallon.

Mix. This mixture contains a little less than 2 per cent. of formaldehyde.

APPLIED DISINFECTION.

In the disinfection of infected rooms and their contents the work cannot usually be well done with a single disinfecting agent or disinfecting process. Special disinfectants and special processes must be employed for special purposes. Thorough work, however, may be done even when the means at one's disposal are but few and simple, but the expense involved in washing the paper from the walls of an infected room will often be more than the cost of the apparatus for using formaldehyde, and the portable steam disinfector may save many times its cost in a single month. These two—formaldehyde and steam disinfection—should be available in every town.

In disinfection it should be remembered that the success of the work is influenced by:

1. Temperature. Disinfecting solutions generally act more efficiently when they are used warm or hot. A somewhat elevated temperature in a room increases also the activity of formaldehyde when used for its disinfection.

2. Time. This is an important element in disinfection. In the treatment of the discharges in the sick-room or of tuberculous sputum, for instance, disinfecting solutions should act several hours.

3. The quantity of the disinfectant. The volume of disinfectant used as compared with that of the infectious material is often much too small. In the following paragraphs note the directions which relate to temperature, time, and quantity.

Infected Houses.—At the beginning and during the whole course of a case of infectious disease, the family and the attendants on the sick should be under instructions as follows so that as small a part of the house as possible may become infected:

Everything not absolutely needed in the sick-room should be removed from it before the patient is carried to it, or before these superfluous things have become infected. This should apply particularly to carpets, draperies, upholstered furniture, and other things disinfected with difficulty.

All the patient's bed and personal clothing should be disinfected as soon as it is removed.

Every other article carried from the infected room should be disinfected then and there.

Rooms.—In the disinfection of rooms the fact should be kept in mind that the chief task before us is the destruction of infectious dust. In every movement, therefore, we should be on our guard against the danger of whisking it into the air or diffusing it through other rooms.

Before the disinfection of the rooms themselves is begun, a preliminary sorting out should be done. Some things, clothing and some or all of the bedding particularly, should be removed for separate or special treatment. (See "Clothing," "Bedding," etc.) In the disinfection of rooms, one of two processes may be employed:

1. Disinfection with formaldehyde is by far the most convenient. Properly used it can be trusted to disinfect the exposed surfaces of walls, floors, furniture, etc., and the infectious dust of the room. If there is a probability that infectious sputum has been dried upon walls, floors, or furniture, as is very likely to be true in some cases of diphtheria, scarlet fever, or consumption, the disinfection of the surfaces thus probably soiled is facilitated if they are washed or sprayed with a 2 per cent. solution of formaldehyde (Solution 7) before the disinfection with formaldehyde gas is begun. (See "Formaldehyde.")

2. If formaldehyde disinfection is not available the next most trustworthy process is washing all surfaces with a disinfecting solution (Solution 1, 2, 6, or 7). Floors, particularly, should receive careful treatment and the solution should reach and wet the dust and dirt in the cracks. The ceiling may be brushed with a damp cloth to remove infectious dust and stray cobwebs. The walls should be wiped carefully with a sponge or cloth squeezed out of a disinfecting solution. When the walls are papered, it will be a case of injured walls or incomplete disinfection. The local board or the owner must decide.

With the cloth dampened in the solution wipe the dust carefully from all horizontal or other surfaces that can harbor it, furniture, moldings, doors, windows, etc. (See "Furniture.")

Cotton and Linen Clothing.—The most trustworthy agency for the disinfection of clothing generally is moist heat,—steam or boiling. Steam disinfection wets the goods less than boiling, does not shrink woolens so much, and is less likely to change the colors of fabrics. Boiling for one-half hour insures the disinfection of all clothing thus treated.

When infected bed or body linen is removed, it may be treated differently according to circumstances. If stained, it should be soaked some hours in a disinfecting solution at a temperature not exceeding 120° F. For this purpose Solution 2, half strength, is especially appropriate as having the properties of a soap and a disinfectant; or Solution 1 mixed with an equal quantity of soap and water, may be used. Subsequent boiling, as in the ordinary laundry processes, will complete the disinfection. Unstained clothing may be immersed in Solution 1, 2, or 7, one-half strength, or in Solution 6, and then treated as already advised, or it may be transferred immediately to the wash boiler or steam disinfector. If Solution 6 is used, the clothing should be taken from it and well rinsed before it is transferred to the wash boiler.

Clothing which has been immersed in the disinfecting solution, or is otherwise wet, is not readily penetrated by the heat in steam disinfection. In transferring infected clothing from the sick-room, it should be wrapped in a sheet wet in a disinfecting solution or in simple water if the disinfecting solution is not at hand. Infected clothing should never be sent to public laundries.

Woolen Clothing.—Disinfect with steam when available; when not, in solutions as under "Cotton and Linen Clothing," or with large doses of formaldehyde in small, tight, enclosed spaces. (See "Formaldehyde.")

Bedding.—When steam disinfection is available, quilts, comforters, blankets, pillows, etc., should be treated in it, and mattresses also if the apparatus is large enough. In the absence of a steam disinfector, proceed as follows.

A. The room is to be disinfected with formaldehyde.

Even if formaldehyde is to be used, counterpanes, quilts, comforters, blankets, sheets, and pillow-cases should be removed for steam disinfection in the wash boiler, or in Solution 1, 2, 6, or 7. If these articles of bedding are left in the room their disinfection with formaldehyde will be uncertain, and the same will be true of that part of the surfaces of furniture and floors covered by them.

Disinfect pillows and feather beds with steam in the wash boiler or with large doses of formaldehyde in small enclosures.

that are practically gas-tight, as a small closet or tight dry goods box pasted if necessary, or an oilcloth bag. (See "Formaldehyde.")

Leave mattresses upon the bedstead wholly exposed to formaldehyde when the room is disinfected. If the mattresses have been soiled by the penetration of discharges, as sometimes happens in cases of typhoid fever, the owners should be advised to burn them. The only safe alternative is the injection of large quantities of formaldehyde (the gas or formalin) into their interiors while they are enclosed in a gas-tight covering.

Mattresses of but little value should be burned if the facilities for their sure disinfection are not at hand.

The contents of straw beds should be burned. The ticks may then be disinfected as for clothing.

B. The room is not to be disinfected with formaldehyde.

Proceed as in A with the exception that the surfaces of bed mattresses should be washed with a sponge or cloth squeezed out of Solution 1, 2, or 6.

When practicable the removal of the larger pieces of bedding should be through a window into the open air instead of through other rooms.

Furniture.—The rules may here also be arranged under two subheadings.

A. Formaldehyde is to be used.

Then simply leave all pieces of furniture in the room, all their parts well exposed to the action of the gas.

B. Formaldehyde is not available.

The disinfection must then be done with disinfecting solutions (Solution 1, 2, or 6). Dip a large, soft sponge or cloth into the disinfecting solution and, squeezing it out more or less according to the nature of the articles to be disinfected, wash or wipe carefully every part of the surface of the woodwork of furniture, its upholstered parts, leathern, glass, or metallic* articles, and toys. Toys of little value should be burned. Upholstering and the unfinished backs of furniture should be thoroughly washed. Pictures covered with glass may be rubbed with a dampened cloth. Uncovered pictures should be wiped with a soft, dry cloth. All parts of furniture where

* Solution 6 should not be used on metallic or gilt articles.

dust has lodged should receive careful and thorough treatment.

After this treatment upholstered furniture should be carried out-doors and exposed to direct sunshine several days.

Rugs and Carpets.—Disinfect rugs with steam or with formaldehyde as under "Bedding—A." Fur rugs must not be subjected to steam.

If, unfortunately, a carpet was left upon the floor of the sick-room it should be removed before the room is disinfected and treated as follows:

A. By steam disinfection if a steam disinfecting chamber of ample size is available.

B. If steam disinfection is not available, subject it to formaldehyde as under "Bedding—A."

C. If neither steam nor formaldehyde can be used, spray or sprinkle the carpet upon both sides until it is thoroughly wet with Solution 1, 6, or 7. Beside these processes the only safe alternative is burning and this is advisable for rugs and carpets of little value.

Furs, Skins, Etc.—These can be efficiently disinfected only with formaldehyde as under "Bedding—A," or by spraying or sprinkling very thoroughly with a disinfecting solution.

Boots, Shoes and Other Leathern Articles.—Wash in Solution 1, 2, 3, or 6, or expose to formaldehyde.

Excreta.—In the sick-room the discharges from the bowels may be treated with any of the solutions given in this circular save Solution 6 and 7. Solution 3, 2, or 4 is slightly preferable when obtainable.

Disinfecting solutions should act three or four hours at least. A still longer time is better. The quantity of 1, 2, or 3 used should be at least twice the volume of the discharge. If 4 or 5 is used the quantity should be much larger. The intimate mixture of the disinfecting solution and the material to be disinfected is important.

A sure way to disinfect fresh excreta is to pour upon it in the vessel at least four or five times its volume of boiling water, to cover the vessel, and to let it stand until cool.

Privy Vaults.—Disinfect with Solution 4 or with "milk of lime" prepared as whitewash is made, or as is directed for Solution 5. It should be used in large quantity sufficient to saturate

thoroughly the contents; and after the vault is emptied, gallon after gallon should be poured in until the ground beneath the privy is thoroughly saturated with the milk of lime.

Cesspools.—Disinfect as under "Privy Vaults."

Water-Closets.—If they have received infectious discharges the bowls should be scrubbed out with Solution 1, 2, or 3.

Sputum.—Fresh tuberculous sputum is hard to disinfect. It may be received on pieces of rag or paper and burned. In spittoons it may be disinfected with Solution 2, 3, or 1. The efficiency of these solutions is increased by using them hot, and that of Solution 1 by acidifying it with hydrochloric acid (2 ounces to 1 gallon of the solution,) or by the addition of common salt (12 to 14 ounces.) These solutions should act twenty-four hours. This necessitates several spit cups or spittoons for the patient.

Tuberculous sputum may also be disinfected by filling the spittoon with boiling water, covering it, and letting it stand until it is cooled. The cleansing of the spittoon is facilitated by the addition of washing soda before the hot water is poured in.

The treatment of other infectious sputa should be the same as that of tuberculous sputum.

Corpses.—Wrap in a sheet wet in Solution 6, 7, or 2, and bury as speedily as possible.

Mouth and Throat of Nurses and Attendants as a Prophylactic.—Rinse in a 1 per cent. solution of formalin, or five drops of formalin in one ounce of water.

Clothing of Nurses and Physicians.—Steam is preferable. For the physician's suit, two or three ounces of formalin may be poured on a rag beside it in a tin wash boiler or gas-tight box of about the same size. Close tightly. Leave over night. It cannot be worn until thoroughly aired.

Form 44.

DIPHTHERIA.

Its Prevention and Restriction.

Edition of 1898.

Issued by the State Board of Health of Maine.

Diphtheria is a contagious and infectious disease, attacking persons of all ages, but affecting children much more frequently than it does adults. It may be communicated from the sick to the well by means of cups or other articles which pass from mouth to mouth, or through the medium of the air of infected rooms, or it may be spread by means of clothing or other infected things.

That diphtheria is a germ disease is well established. That this germ is capable of retaining its life a long while under favorable circumstances is shown by the histories of many outbreaks referable to infected clothing or other things which have been laid away without disinfecting, and brought forth or unpacked months or years later. Infected rooms and furniture, also, figure quite often as the origin of outbreaks of diphtheria.

These facts call most urgently for extreme care not to carry or scatter the infection from the sick-room to other parts of the house, or to other houses, nor to overlook a single infectious article when disinfection is done.

The very fact that this contagion is long-lived renders it more difficult to trace it from case to case, and makes it quite likely that many unexplained outbreaks are due to infected things forgotten or unknown.

PREVENTION.

Keep away from the sources of contagion. Do not go where the disease is, if you can help it; and, above all, do not let your children go where it is. Permit no one to come to your home who has been where diphtheria is or who has recently had this disease.

When diphtheria is rife, keep from the children gum, jews-harps, harmonicas, pencils, school-room drinking cups, and other things which may pass from mouth to mouth.

What is apparently only a common sore throat in adults often gives rise to outbreaks of diphtheria in children; therefore, in all cases of sore throat, prudence dictates caution in using dishes which the patients have used. A kiss to a child under these circumstances may be the unconscious seal of the little one's death warrant.

RESTRICTION.

When it is found that a person has diphtheria, he should immediately be separated from the rest of the family and put into a sunny and well-ventilated room, preferably on the upper floor, and as disconnected as possible from other rooms, especially the living and sleeping rooms of children.

Before moving the patient into the room, all needless articles, such as carpets, contents of wardrobes, etc., which would catch the infection should be removed.

No other person beside the nurse and necessary attendants should be permitted in the room, and they should take special precautions not to carry the infection. Their communication with the rest of the family should be as restricted as possible.

Neither the nurse nor any other person should eat or drink anything in the sick-room or anything which has been there. Food which the patient has left should be burned. The dishes which the patient uses should not be used by others, or washed with other dishes. They should be washed by themselves in boiling-hot water.

Cats and dogs should be kept from the sick chamber, or better, out of the house, for their fur can easily carry the infection. These animals, as well as some others, sometimes have diphtheria, and communicate it to children.

DISINFECTION.

1. The work of disinfection should begin with the beginning of the treatment of cases and should continue during the whole course of the disease. All articles of bed clothing and of body clothing should be disinfected as soon as they are removed from the bed or from the patient.

2. The disinfection work should be carried out in conformity with the following rules as far as possible. No bedding or other property of value should be burned or otherwise destroyed if it can be avoided.

3. Steam disinfection or disinfection by boiling should be employed so far as these methods are applicable and practicable. Boiling one-half hour will disinfect any article that can be subjected to it. Steam disinfection, properly done, is just as trustworthy, and has the advantage of wetting the goods less.

Steam disinfection on a small scale can be done in the common wash boiler by supporting, above the water with two bricks or otherwise, a false flooring of laths or thin board. Pour in two or three inches of water, place the articles to be disinfected above the false flooring, put on the cover, and steam one hour after the water begins to boil, keeping the water briskly boiling all the time. After the steaming, carry the boiler into the open air and throw the things over a line to dry.

4. *Cotton and Linen Clothing.*—Disinfection may be done by immersion in Solution 1 or 2, one-half strength. The clothing should remain in the solution ten or twelve hours at least, and then it may be put through the usual laundry processes. Or the clothing may be transferred directly from the patient or his bed to a cold or preferably lukewarm solution of soap and water, the temperature of which is later to be raised to the boiling point when efficient disinfection will result.

The utmost care should be taken with the clothing of the patient. Do not carry it from the sick-room dry. In transporting it from the sick-room for disinfection, wrap it in a sheet wet in one of the solutions mentioned in 4, or, in the absence of these, in water.

5. *Woolen Clothing.*—Disinfect with steam or in the solutions under 4.

6. *Bedding.*—Disinfect the bed clothing with steam, or as under 4. Pillows and feather beds should be treated with steam, or with large doses of formaldehyde. If steam disinfection is not available for mattresses, leave in place wholly uncovered when the room is disinfected with formaldehyde. If formaldehyde is not available, wash thoroughly with Solution 2 or 1, full strength, and put out in the sunshine several days,—the longer the better. Mattresses of but little value should be burned if the facilities for their sure disinfection are not at hand. The filling of straw-beds should be burned; then disinfect the ticks as under 4.

When possible the removal of the larger pieces of bedding shouldbe through a window into the open air instead of through other rooms.

7. *Shoes and Other Leathern Articles.*—Wash in Solution 1 or 2, full strength, or expose to formaldehyde.

8. *Rugs and Carpets.*—Disinfect with steam preferably; if not available, with formaldehyde gas in concentrated doses.

9. *Lounges and Other Upholstered Furniture.*—Leave in place when the room is disinfected with formaldehyde. If formaldehyde is not available, spray or wash until well wet with Solution 6 or 7. Then expose the pieces to direct sunshine several days.

10. *Rooms.*—After the infected things have been sorted out and disposed of as in the preceding, disinfect rooms with formaldehyde. If that is not available, wash all surfaces with a disinfecting solution. (Solution 1, 2, 6, or 7.) Surfaces or parts of surfaces that may have become soiled with sputum should be gone over very thoroughly. Floors, particularly, should receive careful treatment and the solution should reach and wet the dust and dirt in the cracks. The ceiling may be brushed with a damp cloth to remove infectious dust and stray cobwebs. The walls should be wiped carefully with a sponge or cloth squeezed out of a disinfecting solution. If the walls are papered, it will be a case of injured walls or incomplete disinfection.

With the cloth dampened in the solution wipe the dust carefully from all horizontal or other surfaces that can harbor it, furniture, moldings, doors, windows, etc.

11. *Excreta.*—In the sick-room the discharges from the bowels may be treated with any of the solutions save Solution 6 and 7. Solution 3, 2, or 4, is slightly preferable when obtainable.

Excreta in privy vaults should be disinfected with Solution 4, or with "milk of lime" prepared as whitewash is made. The disinfectant should be used in large quantity.

12. *Sputum.*—Receive the sputum and the discharges from the nose on pieces of rag or paper and burn, or sputum in vessels may be disinfected with Solution 2, 3, or 1.

13. *Clothing of Nurses and Other Attendants.*—Steam is preferable. A suit may be disinfected by putting it in a tin wash boiler or gas-tight box of about the same size, and pouring an ounce and a half or two ounces of formalin upon a rag beside it. Close tightly and leave over night. It cannot be worn until it has had a prolonged airing.

DISINFECTING SOLUTIONS.

SOLUTION 1. For clothing, woodwork, floors, leather, excreta in the sick-room, sputum, the hands, the person.

SOLUTION 2. For the same general uses as Solution 1. It is a little more efficient than Solution 1; but more likely to injure colors.

SOLUTION 3. For tuberculous sputum, discharges in the sick-room.

SOLUTION 4. For excreta, privy vaults, cesspools, etc.

SOLUTION 5. For the same purposes as Solution 4.

SOLUTION 6. For clothing, the hands, and the surfaces of walls, floors, furniture, etc.

SOLUTION 7. For clothing, the hands, etc.

SOLUTION 1.

Carbolic Acid (pure liquified),	7 ounces.
Water,	1 gallon.

Mix. This is approximately a 5 per cent. solution. Its power is somewhat increased by the addition of from 12 to 14 ounces of common salt to each gallon when used for the disinfection of excreta, or for other uses where the salt is not objectionable.

For the disinfection of clothing this solution mixed half and half with water will do.

SOLUTION 2.

Lysol,	5 ounces.
Water,	1 gallon.

Mix. This may be used as a substitute for Solution 1, one-half the strength sufficing for uncolored clothing. Many colors are changed by it.

SOLUTION 3.

Solutol (crude or pure),	1-2 pint.
Water,	2 or 3 gallons.

Mix. This is a very efficient disinfectant for excreta, tuberculous sputum, and gross disinfection generally. If to be used in dwelling houses, or wherever the odor of the crude product would be offensive, pure solutol should be used.

SOLUTION 4.

Chloride of Lime,	6 ounces.
Water,	1 gallon.

Mix. This is about a 3 per cent. solution. (Decolorizes and destroys fabrics).

SOLUTION 5. "Milk of Lime."

Slake a quart of freshly burnt lime in small pieces with three-fourths of a quart of water,—or to be exact, 60 parts of water by weight with 100 of lime. A dry powder of slaked lime (hydrate of lime) results. Make milk of lime not long before it is to be used by mixing 1 quart of this dry hydrate of lime with 4 quarts of water.

Air-slaked lime is worthless. The dry hydrate may be preserved some time if is enclosed in an air-tight container. Milk of lime should be freshly prepared, but may be kept a few days if it is closely stoppered.

SOLUTION 6.

Corrosive Sublimate,	1 dram.
Water,	1 gallon.

Mix and dissolve. Label, *Poison!* This is approximately a 1:1000 solution. One ounce of this solution contains very nearly half a grain of corrosive sublimate.

SOLUTION 7.

Solution of Formaldehyde (Formalin),	6 ounces.
Water,	1 gallon.

Mix. This mixture contains a little less than 2 per cent. of formaldehyde.

SCARLET FEVER.

Its Prevention and Restriction.

(Edition of 1898.)

Issued by the State Board of Health of Maine.

Scarlet Fever, Scarlatina, Scarlet Rash, and Canker Rash are several names for one and the same disease. The contagion is very readily conveyed long distances in clothing or other things, or even in a letter or a paper sent from the sick-room. The contagion may be preserved for many months in clothing or in rooms, or even in small articles such as handkerchiefs or a doll which escapes disinfection.

After recovery, for several weeks at least, the scarlet fever patient continues to be a source of danger to others, as long at least as the skin continues to be rough and to give off its branny scales of desquamation, or peeling.

PREVENTION.

Keep children away from the disease and away from persons and things that have been where it is. Keep, also, all who have recently been sick with the disease and all who have been where it is away from your children. Scarlet fever is always a dangerous and often a deadly disease. One great reason for warding off scarlet fever is that, after childhood, this disease is not so fatal, and also after childhood the liability to take the disease is very much lessened. It therefore happens that many, escaping the disease in childhood, never have it, though many times exposed to it later in life.

RESTRICTION.

The scarlet fever patient should be put into a room by himself. It is better to have the room in the upper story and at a distance from room inhabited by children. Before the patient is put into the room, remove everything possible which can catch and retain the poison of the disease, viz.: carpets, useless curtains, unused clothing.

Notify the secretary of the local board of health at once.

Have some person specially employed as a nurse, who is not to visit other parts of the house. No other person not needed should be allowed to visit the sick-room, especially those who have children of their own or who must go where children are. The nurse while attending the patient should wear only such clothing as can be disinfected by boiling, before she goes to other places.

No person from a house where scarlet fever is, should go into public assemblies, such as schools, churches or concerts, or anywhere into the presence of children who have not had the disease. Persons who have had scarlet fever should never be allowed to go to school or to mingle in any other way with the public while they remain infectious. They should be considered infectious four or five weeks at least, and in many cases the period of desquamation, or peeling, and of infectiousness is extended to six or eight weeks. The period of infectiousness is prolonged indefinitely when thorough disinfection is neglected.

(The remaining part of this circular, "Disinfection," is practically the same as in the preceding "Circular No. 44.")

TYPHOID FEVER.

Its Prevention and Restriction.

(Edition of 1898.)

Issued by the State Board of Health of Maine.

Typhoid fever is a communicable disease, but is not generally considered contagious or infectious in the general meaning of these terms. In the absence of precautionary measures the disease often prevails unnecessarily.

The infectious germ is given off in the discharges from the patient. The prompt and efficient disinfection of these discharges is, therefore, one of the chief requisites to the prevention of the spread of the disease.

The infection of typhoid fever comes by ingestion,—that is, the typhoid fever germ is swallowed in infected drink or food or, more rarely, it reaches the mouth in infectious dust (from dried infected clothing, for instance.) The communication of the infection usually takes place in some of the following ways:

The discharges from the typhoid fever patients reach sources of drinking water supplies through sewage, the drainage from privies, or otherwise. Water thus infected is the prime cause of typhoid fever. Boil suspicious drinking water: it is thus rendered harmless.

Typhoid fever is sometimes spread from the primary cases in households by the fingers of the nurse or mother who attends to the wants of the sick, and then turns to the preparation of food for the family. An ordinary washing of the hands does not suffice to ensure against the transmission of the germs. (See Disinfection, 10.)

The disease is sometimes widely spread by milkmen whose milking is done by persons whose fingers are infectious, or whose milk supply is kept too near the sick room or the privy vault, or whose milk cans are washed with infected water. Heat suspicious milk to near the boiling point.

It is sometimes spread by means of infectious dust which comes from the personal clothing or the bed clothing that has been soiled with the discharges from the patient and afterwards dried. (See Disinfection, 4 and 5.)

Typhoid fever is, perhaps, sometimes spread by breathing in the exhalations from infected privies. (See Disinfection, 3.)

Disinfection.

1. The work of disinfection should begin with the beginning of the treatment of cases and should continue during the whole course of the disease. All articles of bed clothing and of body clothing should be disinfected as soon as they are removed from the bed or from the patient.

2. The disinfection work should be carried out in conformity with the following rules as far as possible. No bedding or other property of value should be burned or otherwise destroyed if it can be avoided.

3. *Excreta.*—The certain disinfection of the discharges from the patient immediately after they are passed is of prime importance. For this purpose use milk of lime prepared from caustic lime just as whitewash is made; or solution of chloride of lime at the rate of 6 ounces to the gallon of water; or lysol, 5 ounces to the gallon. For the disinfection of fresh excreta a quantity of one of these solutions three or four times as large as the volume of the discharge should be used, and before the final disposal is made the disinfectant should act three or four hours at least. Time is an important element in disinfection, and intimate mixture of the disinfecting solution and the matter to be disinfected is essential.

A sure way to disinfect fresh excreta is to pour upon it, in the vessel, at least four or five times its volume of boiling water, cover the vessel and let it stand until it is cooled.

For the disinfection of excreta in privy vaults use milk of lime in large quantity sufficient to thoroughly saturate the contents, and after the vault is emptied gallon after gallon should be poured in until the ground beneath the ordinary privy is thoroughly saturated with the milk of lime.

The final disposal of typhoid excreta should be with the view of avoiding the possibility of its reaching, by surface drainage or by percolation, rivers, lakes, wells, or springs that serve as

sources of water supply. With disinfected excreta there is always a fair probability of unsuccessful disinfection at some point.

4. *Cotton and Linen Clothing.*—Disinfection may be done by immersion in a solution of carbolic acid (5 ounces to the gallon of water,) or of lysol (3 ounces to the gallon of water.) The clothing should remain in the solution ten or twelve hours at least, and then it may be put through the usual laundry processes. Or the clothing may be transferred directly from the patient or his bed to a cold or preferably luke-warm solution of soap and water, the temperature of which is later to be raised to the boiling point when efficient disinfection will result.

If clothing is soiled it should be removed immediately from the patient or his bed and transferred to the disinfecting solution, or the soap and water solution, before it is dried. Clothing which has not been stained may be disinfected by immediately steaming or boiling. (See Disinfection, 12.)

5. In transporting clothing from the sick room for steam disinfection or boiling, wrap it in a sheet wet in one of the solutions mentioned in 4, or, in absence of these, in water. As an alternative, the steam disinfector or boiler may be carried into the sick room and there filled.

6. *Woolen Clothing.*—Disinfect with steam or solutions under 4.

7. *Bedding.*—Throw straw-beds out of window. Empty out and burn straw. Then disinfect the tick as in 4. Disinfect feather beds, pillows, quilts, comforters, and blankets in steam disinfector when practicable, or if not soiled, formaldehyde. (See 18.) Advise the burning of mattresses if discharges have penetrated them and steam disinfection is impracticable.

8. *Rugs and Carpets.*—Disinfect with steam or formaldehyde if probably infected; or if of but slight value, advise burning. Carpets and rugs only in the sick room will require disinfection.

9. *Lounges, Couches, and Other Upholstered Furniture.*—If possibly soiled by the patient will need disinfection. Leave in place when the room is disinfected with formaldehyde, then, if practicable, carry outdoors and expose to direct sunshine as long as possible. If of little value, strip off and disinfect the covering as in 4. Burn worthless filling.

10. *The Hands of Nurses and Others* who have attended to the wants of the sick should be disinfected by thorough and prolonged washing and scrubbing in hot soap and water, followed by their immersion for several minutes in the solution of carbolic acid or lysol as in 4. Even then the hands cannot be considered "surgically clean."

11. *Sputum.*—To be received on pieces of rag or paper and burned, or if in the cuspidor it may be disinfected with four or five times its volume of boiling water.

Steam Disinfection.

12. Steam disinfection or disinfection by boiling should be employed so far as these methods are applicable and practicable. Boiling one-half hour will disinfect any article that can be subjected to it. Steam disinfection, properly done, it just as trustworthy, and has the advantage of wetting the goods less.

13. A steam disinfector may be ordered as follows at a tinman's:—Make it like a common tin wash boiler, only have it 22 inches square, or made with rounded corners, and 30 inches high. Upon the sides, five inches from the bottom, have brackets attached for the support of a false bottom. This false bottom may be made of heavy galvanized iron perforated with ten or twelve half-inch holes. It should be supported in the middle by a cradle made of galvanized iron wire, or galvanized iron plate, removable for convenience when wiping and drying the bottom. The side brackets for the support of this false bottom should be attached with rivets, so they will not come off if the heat strikes them above the surface of the water, as they might possibly, if used over an open fire outdoors. The part of this steam disinfector beneath the false flooring must be perfectly water-tight; slight leaks in the part above, which is to be filled with steam, are of not so much consequence. Two strong handles should be placed 18 inches from the bottom on opposite sides. Have two half-inch holes in the cover for the escape of steam.

14. When using this steam disinfector put three or four inches of water into it, put in the false bottom, and above that pack in rather loosely the clothing to be disinfected; put the cover on tightly and steam one hour after the water begins to boil, keeping the water briskly boiling all the time. Many

kinds of clothing that would be injured by boiling can be disinfected in this way without injury.

15. After the steaming, the apparatus should be carried into the open air immediately, and the clothing should be thrown over a line. Usually clothing thus treated is not very wet, and will dry in a few moments if spread out in the open air while hot.

16. If you should have this apparatus made of galvanized iron, you would need to have it lined on the inside with thin strips of wood, or with cloth, to keep the clothing from coming in contact with the iron. You can use the apparatus, in most cases, upon the cooking stove, taking off the four covers.

17. Steam disinfection on a small scale can be done in the common tin wash boiler, by supporting, above the water with two bricks or otherwise, a false flooring of laths or thin boards.

Formaldehyde.

18. When the matter to be disinfected is open (well exposed to the gas) formaldehyde gas is much more efficient than the fumes of sulphur. Formaldehyde, also, has a somewhat greater power of penetration than sulphurous acid. It will not, however, be safe to trust to formaldehyde to penetrate deeply into clothing. It may be used very conveniently and efficiently for the disinfection of infected rooms, furniture, or other infected surfaces, at no matter what height in the room.

19. In the disinfection of rooms with formaldehyde gas, the rooms must be flooded with the gas quickly. To disinfect thoroughly 2000 cubic feet of room space, at least a quart of wood alcohol should be changed to aldehyde within an hour and a half. The room should be made as close as possible and should be kept closed for from four to six hours.

20. For the suitable penetration and disinfection of clothing and bedding, they should be treated separately in a small close room or closet, or, if in a large room, at least two quarts of wood alcohol should be used for 2000 cubic feet of room space, and the room should be kept closed not less than six hours. Clothing, when subjected to formaldehyde must be well exposed, preferably over lines. Steam, however, at 212° F. is more trustworthy, for its greater power of penetration. (See 12 to 17.)

WATER ANALYSES.

ANALYSES OF SAMPLES OF WATER—EXPRESSED IN PARTS PER 100,000.

Number of analysis.	Origin of Sample.	Date of collection.	Total solids.	Loss on ignition.	Hardness.	Chlorine.	Free ammonia.	Organic ammonia.	Nitrites.	Nitrates.
		1896.								
1065	Well, Oakland	....	37.4	17.4	12.86	3.0	.002	.012	Heavy trace	Very much.
1066	Well, Vassalboro	January 9,	75.4	27.8	39.20	11.6	.004	.010	Trace	Much.
1067	Spring, Bangor	January 14,	7.2	2.6	6.00	.2	.003	.002	None	Heavy trace.
1068	Spring, Bangor	January 14,	34.4	14.2	13.31	2.6	.005	.007	None	Very much.
1069	Well, Convene	January 15,	1.6	1.2	2.60	.2	.001	.002	None	Trace.
1070	Well, Oakland	January 17,	8.0	2.2	5.14	.6	.000	.003	None	Much.
1071	Well, Oakland	January 17,	55.6	16.2	12.56	7.0	.016	.007	Trace	Very much.
1072	Well, Oakland	January 17,	37.8	19.0	11.05	3.2	.000	.002	Trace	Very much.
1073	Well, West Falmouth	January 18,	18.2	11.2	8.14	3.0	.000	.002	Trace	Very much.
1074	Well, Bangor	February 6,	108.6	15.0	11.80	50.6	.005	.014	Trace	Much.
1075	Well, Bangor	February 6,	32.8	11.4	17.54	7.6	.001	.003	Trace	Very much.
1076	Spring, Convene	February 24,	2.2	.6	1.95	.1	.000	.002	Very slight trace.	Trace.
1077	Spring, Bangor	March 16,	13.0	4.0	10.30	1.0	.001	.005	Slight trace	Much.
1078	Spring, Deering	March 15,	3.6	2.8	3.25	.4	.003	.007	Very slight trace,	Trace.
1079	Spring, Ash Point	March 15,	3.0	2.4	3.25	.6	.001	.002	Slight trace	Heavy trace.
1080	Well, Gray	March 17,	67.6	12.8	34.44	7.2	.376	.040	Heavy trace	Very much.
1081	Spring, Bangor	March 16,	17.6	4.8	18.02	.8	.035	.002	Trace	Slight trace.
1082	Well, Belfast	March 6,	30.0	7.4	20.40	4.0	.003	.005	Trace	Much.
1083	Well, Bangor	March 27,	27.0	15.0	10.30	3.6	.002	.017	Trace	Very much.
1084	Well, Bangor	March 27,	23.0	3.8	15.63	2.0	.001	.002	Slight trace	Heavy trace.
1085	Well, Mexico	April 17,	2.8	1.0	3.25	.2	.000	.006	Trace	Heavy trace.
1086	Well, St. George	April 19,	37.6	17.6	22.02	6.2	.003	.005	Slight trace	Very much.
1087	Spring, Pittsfield	April 19,	14.0	4.0	16.43	.4	.000	.004	Slight trace	Much.
1088	Spring, Lewiston	May 2,	10.4	2.0	11.05	.6	.003	.003	Slight trace	Heavy trace.
1089	Well, Berwick	May 4,	19.2	7.4	10.30	2.6	.001	.009	Very slight trace,	Much.
1090	Well, Hallowell	May 12,	52.6	10.8	45.72	3.2	.024	.009	Heavy trace	Heavy trace.
1091	Well, Westfield Plantation	May 26,	20.0	3.2	22.86	.2	.000	.003	Trace	Much.

1092	Spring, Portland	May	26,	37.8	13.4	22.02	5.6	.001	.002	Slight trace	Very much.
1093	Spring, Portland	May	28,	40.0	14.4	22.02	5.6	.002	.021	Slight trace	Very much.
1094	Cistern, Dexter	June	1,	9.4	6.8	6.71	.2	.018	.071	None	Very slight trace.
1095	Well, Dexter	June	1,	32.4	12.0	22.86	2.6	.003	.005	Very slight trace	Much.
1096	Well, Orrington	June	5,	58.0	20.0	26.62	9.4	.001	.012	Trace	Very much.
1097	Well, Orrington	June	5,	10.0	4.6	7.43	.8	.010	.009	Trace	Much.
1098	Well, Orrington	June	5,	5.6	3.6	5.29	.5	.008	.011	Trace	Heavy trace.
1099	Pond, Sabattus	June	8,	3.0	.8	3.90	.2	.021	.031	Very slight trace,	Very slight trace.
1100	Spring, Sabattus	June	8,	5.4	3.0	3.51	.2	.002	.002	Very slight trace,	Heavy trace.
1101	Spring, Sabattus	June	9,	3.2	1.8	3.25	.3	.002	.002	Very slight trace,	Trace.
1102	Well, Sabattus	June	9,	30.2	11.2	26.62	4.0	.002	.002	Very slight trace,	Very slight trace.
1103	Well, Anson	June	10,	5.0	1.8	4.57	.3	.001	.002	Trace	Heavy trace.
1104	Spring, Hiram	June	13,	4.0	1.8	2.90	.1	.000	.000	None	Very slight trace.
1105	Pond, Avon	June	18,	2.2	1.6	1.95	.1	.003	.016	None	Very slight trace.
1106	Well, Waterville	June	19,	64.8	23.4	18.81	3.0	.000	.009	Very slight trace,	Much.
1107	Spring, Auburn	June	19,	24.2	11.0	11.05	2.6	.001	.002	Slight trace	Much.
1108	Well, Belfast	June	20,	23.6	6.8	13.31	2.2	.001	.003	Very slight trace,	Much.
1109	Well, Newport	June	22,	35.0	13.6	21.19	5.4	.079	.019	Much	Much.
1110	Spring, West Moscow	June	23,	4.8	1.4	7.43	.1	.000	.002	Much	Trace.
1111	Well, Albion	June	22,	27.8	8.0	22.86	8.8	.079	.017	Heavy trace	Much.
1112	Well, Waldoboro	June	23,	11.6	4.4	14.06	.6	.008	.013	Much	Very slight trace.
1113	Well, Sebago	June	22,	9.8	2.6	6.71	.2	.001	.002	Trace	Very slight trace.
1114	Well, North Nobleboro	June	24,	16.4	7.6	13.31	2.0	.003	.005	Trace	Much.
1115	Spring, Pittsfield	June	23,	10.8	4.8	13.31	.1	.000	.000	Very slight trace,	Trace.
1116	Spring, Pittsfield	June	23,	6.2	2.0	8.14	.0	.000	.002	Very slight trace,	Slight trace.
1117	Spring, Bangor	June	23,	16.8	5.6	14.84	.8	.049	.002	Trace	Very slight trace.
1118	Well, Winthrop	June	23,	14.2	3.8	8.14	1.2	.016	.016	Trace	Very slight trace.
1119	Well, Winthrop	June	23,	4.6	2.4	3.90	.1	.003	.006	Trace	Slight trace.
1120	Well, Houlton	July	7,	26.2	5.6	18.81	1.6	.000	.016	Slight trace	Heavy trace.
1121	Water Supply, Hallowell	July	13,	4.6	4.2	3.64	.4	.003	.018	Very slight trace,	Very slight trace.
1122	Well, Bridgton	July	23,	9.8	8.0	3.64	.8	.001	.006	Trace	Very much.
1123	Spring, Portland	July	23,	14.0	8.0	5.57	1.0	.005	.003	Trace	Much.
1124	River, Calais	July	24,	3.0	1.6	2.34	.1	.003	.017	Very slight trace,	Very slight trace.
1125	Well, Sanford	July	25,	4.0	2.6	3.25	.3	.001	.002	Very slight trace,	Very slight trace.
1126	Spring, Sanford	July	25,	7.0	6.6	3.64	.6	.003	.002	Heavy trace	Heavy trace.
1127	Spring, Hallowell	July	30,	4.6	2.4	3.64	.6	.000	.003	Very slight trace,	Heavy trace.
1128	Well, Portland	July	31,	9.6	4.0	8.66	1.2	.000	.003	Trace	Much.
1129	Spring, Monmouth	August	5,	4.0	3.6	3.25	.2	.000	.001	Heavy trace	Trace.
1130	Spring, Monmouth	August	5,	3.4	2.4	3.25	.2	.000	.001	Very slight trace,	Trace.
1131	Lake, Kineo	August	9,	7.8	2.0	5.29	.8	.005	.002	Heavy trace.	Heavy trace.
1132	Spring, Kineo	August	9,	8.2	3.2	6.00	.1	.007	.008	Slight trace	Very slight trace.
1133	Well, Yarmouth	August	9,	16.0	5.6	4.57	.5	.201	.007	Much	Heavy trace.
1134	Well, Waterville	August	12,	82.4	42.0	40.16	9.6	.009	.026	Very much	Very much.
1135	Spring, Yarmouth	August	14,	4.4	2.4	2.34	.3	.009	.007	Much	Trace.
1136	Well, Portland	August	15,	4.4	2.6	3.90	*1.4	.014	.011	Trace	Very slight trace.
1137	Well, Old Orchard	August	26,	5.8	2.2	1.95	.9	.000	.003	Very slight trace,	Very slight trace.
1138	Well, Old Orchard	August	26,	6.2	3.2	3.90	1.0	.003	.003	Trace	Heavy trace.

ANALYSES OF SAMPLES OF WATER—EXPRESSED IN PARTS PER 100,000—Continued.

Number of analysis.	Origin of sample.	Date of collection.	Total solids.	Loss on ignition.	Hardness.	Chlorine.	Free ammonia.	Organic ammonia.	Nitrites.	Nitrates.
1139	Well, Prout's Neck	August 27,	9.0	2.8	6.00	1.2	.002	.003	Very slight trace	Very slight trace.
1140	Well, Readfield	August 29,	49.2	23.2	22.86	4.0	.002	.005	Slight trace	Much.
1141	Well, Ashland	September 9,	22.2	8.2	14.06	1.0	.000	.007	Very slight trace	Much.
1142	Well, Ashland	September 9,	32.0	8.6	19.60	1.4	.003	.002	Slight trace	Much.
1143	Well, Waldoboro	September 14,	4.6	3.0	3.25	.4	.006	.012	Trace	Trace.
1144	Well, York	September 13,	10.2	4.2	5.29	1.2	.001	.006	Trace	Much.
1145	Well, East Orrington	September 15,	6.0	2.8	1.95	.3	.004	.018	Very slight trace	Trace.
1146	Well, East Orrington	September 15,	7.4	3.4	5.29	.8	.059	.016	Much	Much.
1147	Well, East Orrington	September 15,	20.4	5.0	9.57	2.6	.003	.003	Heavy trace	Much.
1148	Lake, Kineo	September 12,	16.4	7.2	10.30	3.2	.001	.002	Heavy trace	Much.
1149	Well, Livermore Falls	September 19,	8.0	4.4	7.43	.3	.000	.006	Trace	Very slight trace.
1150	Water supply, Lewiston	September 26,	6.2	5.0	8.25	.2	.016	.031	Very slight trace	Very slight trace.
1151	Well, Sanford	October 2,	6.0	2.6	5.29	.6	.003	.003	Trace	Heavy trace.
1152	Well, Limestone	October 1,	87.4	5.2	21.19	.9	.000	.003	Slight trace	Much.
1153	Well, Limestone	October 1,	41.2	8.0	22.86	1.6	.000	.002	Trace	Much.
1154	Well, Portland	October 5,	12.4	4.6	4.57	3.0	.016	.011	Heavy trace	Heavy trace.
1155	Water supply, Lewiston	October 3,	6.2	3.4	3.25	.1	.004	.022	Very slight trace	Very slight trace.
1156	Water supply, Lewiston	October 3,	6.0	3.8	3.25	.1	.000	.013	Trace	Very slight trace.
1157	Well, Eliot	October 6,	33.6	16.8	16.43	3.4	.001	.012	Trace	Much.
1158	Well, Bangor	October 5,	13.4	4.4	9.57	1.2	.004	.005	Slight trace	Much.
1159	Well, East Newport	October 12,	42.4	9.2	18.81	6.4	.003	.032	Very slight trace	Much.
1160	Well, Farmington	October 20,	11.6	5.0	6.71	1.2	.003	.006	Very slight trace	Much.
1161	Spring, South Freeport	November 2,	6.0	2.6	4.57	.3	.000	.010	Slight trace	Very slight trace.
1162	Spring, Augusta	November 2,	34.0	9.0	11.80	3.6	.000	.003	Very slight trace	Much.
1163	Spring, Washington	November 2,	3.0	1.4	2.34	.2	.000	.002	Very slight trace	Very slight trace.
1164	Well, Fryeburg	November 3,	2.4	.8	3.25	.2	.000	.000	Very slight trace	Slight trace.
1165	Well, Kennebunk	November 3,	8.6	2.8	5.71	1.4	.034	.003	Heavy trace	Heavy trace.
1166	Well, Bowdoinham	November 4,	12.0	4.8	5.29	1.2	.000	.006	Slight trace	Much.

1167	Spring, Riverside	November	3,	8.0	2.0	6.71	.2	.000	.001	Very slight trace	Trace.
1168	Well, Readfield	November	6,	37.6	7.0	9.57	2.4	.003	.006	Trace	Much.
1169	Spring, Sabattus	November	4,	10.4	2.0	6.71	.2	.000	.001	Slight trace	Heavy trace.
1170	Well, Milo	November	6,	26.8	11.8	14.06	3.4	.001	.011	Trace	Trace.
1171	Well, Milo	November	6,	40.6	11.2	19.60	3.4	.000	.004	Slight trace	Much.
1172	Well, Vassalboro	November	8,	37.0	8.0	21.19	3.6	.001	.016	Slight trace	Much.
1173	Spring, Bangor	November	9,	5.6	2.0	2.99	.1	.000	.018	Heavy trace	Trace.
1174	Well, Stockton Springs	November	10,	13.2	4.4	8.86	1.0	.000	.003	Much	Much.
1175	Spring, Augusta	November	9,	79.6	25.6	20.40	8.4	.008	.013	Slight trace	Much.
1176	Water supply, Mechanic Falls	November	10,	7.4	4.8	4.16	.3	.001	.030	Very slight trace	Very slight trace.
1177	Brook, Mechanic Falls	November	10,	5.6	2.8	3.51	.4	.002	.016	Very slight trace	Very slight trace.
1178	Well, Newry	November	12,	3.4	1.6	2.69	.1	.000	.002	Slight trace	Trace.
1179	Spring, Bangor	November	20,	15.2	3.0	17.22	.4	.001	.003	Trace	Much.
1180	Well, Bangor	November	19,	15.6	7.2	14.84	1.6	.000	.000	Very slight trace	Much.
1181	Well, Hebron	December	9,	14.6	3.0	12.56	.7	.000	.003	Very slight trace	Trace.
1182	Well, Waterville	December	12,	25.4	21.2	12.56	10.2	.108	.016	Very much	Very much.
1183	Spring, Riverside	December	18,	10.4	1.6	9.57	.3	.000	.002	Very slight trace	Slight trace.
1184	Spring, Waterville	December	27,	6.4	2.0	6.00	.2	.001	.007	Very slight trace	Very slight trace.
		1897.									
1185	Well, Limington	January	4,	2.0	1.2	2.60	.2	.000	.003	Slight trace	Slight trace.
1186	Spring, Auburn	January	11,	22.6	9.6	10.30	2.8	.000	.007	Slight trace	Much.
1187	Well, Pittsfield	January	6,	49.0	13.8	16.43	5.2	.013	.016	Much	Much.
1188	Well, Costigan	January	16,	21.2	4.2	8.86	4.4	.002	.040	Slight trace	Much.
1189	Spring, Old Orchard	January	23,	7.0	3.6	6.00	.6	.003	.005	Very slight trace	Much.
1190	Water supply, Lewiston	February	3,	7.2	4.2	4.57	.0	.006	.019	None	Very slight trace.
1191	Water supply, Mechanic Falls	February	8,	3.6	2.0	3.90	.2	.003	.011	Heavy trace	Trace.
1192	Water supply, Pittsfield	February	15,	4.4	3.6	4.57	.2	.003	.017	Trace	Trace.
1193	Well, Pittsfield	February	15,	15.2	3.0	11.80	.4	.000	.013	Trace	Trace.
1194	Spring, Union	February	16,	5.4	2.8	3.90	.2	.000	.002	Trace	Heavy trace.
1195	Spring, Madison	February	17,	21.2	6.4	6.71	7.0	.003	.003	Heavy trace	Much.
1196	Spring, Augusta	February	25,	22.0	8.8	12.86	3.2	.000	.005	Slight trace	Much.
1197	Reservoir, Unity	February	25,	8.8	1.8	8.57	.2	.000	.002	Trace	Heavy trace.
1198	River, Rumford Falls	March	24,	5.8	3.0	4.57	.0	.001	.015	None	Very slight trace.
1199	Spring, Corinna	April	1,	7.8	2.2	8.14	.2	.001	.008	None	Heavy trace.
1200	Well, Bangor	April	2,	32.8	12.0	14.84	3.6	.000	.002	Trace	Very much.
1201	Well, Bangor	April	2,	33.4	11.0	16.43	3.6	.000	.003	Very slight trace	Much.
1202	Water supply, Mechanic Falls	April	14,	4.4	3.0	3.25	.2	.003	.015	None	Very slight trace.
1203	Well, Portland	April	21,	61.0	5.4	14.84	16.2	.004	.009	Heavy trace	Very much.
1204	Spring, Waterville	April	23,	16.0	4.8	13.31	.6	.001	.002	Very slight trace	Trace.
1205	Well, Dennysville	April	27,	48.8	20.6	19.60	6.2	.121	.015	Very much	Very much.
1206	Well, South Casco	May	6,	20.8	8.0	7.43	3.8	.001	.007	Slight trace	Much.
1207	Well, Bangor	May	5,	10.4	5.6	6.00	1.0	.003	.005	Slight trace	Much.
1208	Spring, Chelsea	May	18,	2.8	1.4	2.34	.3	.001	.002	Slight trace	Heavy trace.
1209	Spring, Portland	June	1,	2.4	1.6	2.99	.7	.001	.006	None	Heavy trace.
1210	Well, South Berwick	June	2,	27.6	9.6	14.06	2.0	.000	.005	None	Much.
1211	Spring, Warren	June	2,	4.8	.8	6.00	.4	.006	.006	Trace	Heavy trace.

ANALYSES OF SAMPLES OF WATER—EXPRESSED IN PARTS PER 100,000—Continued.

Number of analysis.	Origin of Sample.	Date of collection.	Total solids.	Loss on ignition.	Hardness.	Chlorine.	Free ammonia.	Organic ammonia.	Nitrites.	Nitrates.
1212	Spring, Warren	June 2,	12.2	3.0	5.29	.6	.001	.003	Slight trace	Heavy trace.
1213	Spring, Warren	June 2,	19.0	4.4	4.57	.4	.003	.009	Very slight trace	Trace.
1214	Pond, Kingfield	June 6,	3.4	2.8	1.95	.0	.000	.008	None	Very slight trace.
1215	Well, Kingfield	June 6,	20.4	7.8	11.80	1.4	.001	.007	Trace	Very much.
1216	Well, Augusta	June 12,	19.8	7.2	6.71	3.8	.000	.021	Trace	Heavy trace.
1217	Well, Mattawamkeag	June 12,	5.8	1.6	6.00	.1	.000	.002	Trace	Heavy trace.
1218	Well, Oakland	May 21,	17.4	7.2	8.86	2.2	.000	.012	Trace	Much.
1219	Spring, Waldoboro	June 22,	5.2	2.4	8.25	.8	.000	.002	Very slight trace	Very slight trace.
1220	Spring, Waldoboro	June 22,	4.8	2.8	3.90	.8	.000	.001	Very slight trace	Very slight trace.
1221	Well, Dexter	June 24,	40.2	21.2	18.81	3.0	.000	.003	Very slight trace	Very much.
1222	Well, Dennysville	June 24,	22.8	8.4	11.05	2.6	.004	.013	Very slight trace	Much.
1223	Spring, Augusta	July 7,	29.2	10.4	8.86	2.0	.000	.001	Very slight trace	Trace.
1224	Well, Saco	July 12,	36.2	14.0	11.05	3.2	.025	.017	Much	Much.
1225	Well, Wilton	July 13,	6.6	3.4	3.25	.2	.000	.002	None	Trace.
1226	Well, Belmont	July 16,	21.6	11.4	11.80	3.8	.002	.007	Trace	Much.
1227	Spring, Waterville	July 16,	56.0	25.4	11.80	7.8	.001	.006	Much	Much.
1228	Well, Brownville	July 19,	30.0	10.4	8.66	3.4	.001	.039	Heavy trace	Heavy trace.
1229	Well, Brownville	July 19,	8.4	5.2	3.25	.4	.001	.003	Trace	Heavy trace.
1230	Well, Yarmouth	July 27,	7.0	3.0	8.90	1.2	.000	.006	Very slight trace	Trace.
1231	Well, Wilton	July 29,	6.4	2.4	5.29	.2	.002	.005	Trace	Slight trace.
1232	Well, Livermore Falls	July 28,	18.8	10.0	6.00	2.2	.002	.005	Trace	Much.
1233	Spring, Greenville	July 29,	4.6	3.4	3.25	.0	.003	.002	Very slight trace	Slight trace.
1234	Well, Bangor	July 30,	68.6	17.4	18.81	12.2	.008	.009	Very slight trace	Very much.
1235	Well, Portland	July 31,	63.4	6.6	12.56	15.8	.001	.006	Very slight trace	Much.
1236	Lake, Livermore Falls	August 3,	3.4	3.0	1.96	.2	.002	.016	None	Very slight trace.

1237	Well, Portland	August 9,	7.2	3.6	3.25	1.2	.001	.002	Very slight trace	Trace.
1238	Well, Eliot	August 10,	10.6	3.6	6.71	.4	.004	.008	Slight trace	Heavy trace.
1239	Well, Eliot	August 10,	29.4	7.6	11.80	2.4	.000	.008	Slight trace	Much.
1240	Well, Berwick	August 30,	16.0	9.6	6.00	1.2	.001	.003	None	Trace.
1241	Spring, Cornish	August 30,	3.6	1.6	3.25	.2	.000	.003	None	Very slight trace.
1242	Well, Popham Beach	September 1,	4.8	1.2	1.95	1.4	.001	.002	Very slight trace	Very slight trace.
1243	Well, Lyman	September 3,	20.4	3.0	2.60	4.4	.001	.010	Very slight trace	Very slight trace.
1244	Spring, Lyman	September 5,	5.6	1.6	4.57	.4	.000	.003	Very slight trace	Very slight trace.
1245	Spring, Waterville	September 13,	17.0	3.4	14.84	.4	.004	.001	Very slight trace	Very slight trace.
1246	Well, Orr's Island	September 13,	39.2	11.6	48.86	14.6	.007	.038	Very slight trace	Very slight trace.
1247	Well, Augusta	September 15,	24.4	4.2	14.06	1.8	.002	.011	Slight trace	Trace.
1248	Well, Bath	September 14,	4.0	1.8	5.29	.6	.001	.002	Very slight trace	Very slight trace.
1249	Well, Milo	September 15,	24.0	3.8	11.05	3.6	.001	.005	Heavy trace	Heavy trace.
1250	Spring, Augusta	September 10,	19.0	6.6	14.06	.3	.001	.003	Much	Very slight trace.
1251	Spring, Waterville	September 15,	8.0	3.0	7.43	.3	.000	.001	None	Very slight trace.
1252	Kennebec river, Waterville	September 21,	4.6	3.0	4.57	.3	.007	.023	Very slight trace	Very slight trace.
1253	Well, Steep Falls	September 29,	10.0	6.0	3.90	.6	.000	.005	None	Heavy trace.
1254	Well, Steep Falls	September 29,	13.8	3.6	5.29	1.6	.000	.004	Slight trace	Trace.
1255	Well, Steep Falls	September 29,	4.2	2.2	2.60	.4	.000	.004	None	Very slight trace.
1256	Well, Steep Falls	September 29,	42.6	9.6	9.57	15.6	.001	.009	Trace	Heavy trace.
1257	Well, Prout's Neck	October 4,	10.6	3.6	6.71	2.0	.006	.006	Trace	Very slight trace.
1258	Well, Whiting	October 2,	20.0	5.6	8.86	3.8	.000	.008	Trace	Heavy trace.
1259	Spring, Sidney	October 2,	6.6	1.6	6.00	.3	.003	.003	None	Very slight trace.
1260	Water supply, Lewiston	October 4,	7.2	5.0	3.25	.1	.000	.014	Very slight trace	None.
1261	——, Auburn	October 8,	5.0	4.4	3.90	.4	.001	.002	Very slight trace	Very slight trace.
1262	Well, Limington	October 11,	24.4	5.4	5.29	5.0	.003	.027	Trace	Trace.
1263	Spring, Limington	October 11,	2.6	2.0	1.27	.2	.000	.000	Very slight trace	None.
1264	Water supply, Winterport	October 19,	6.2	1.6	7.43	.4	.001	.003	None	Very slight trace.
1265	Water supply, Winterport	October 18,	8.6	3.6	7.43	.4	.000	.002	None	Very slight trace.
1266	Well, Old Town	October 25,	35.6	7.2	14.84	5.4	.000	.015	Slight trace	Heavy trace.
1267	Well, Hallowell	Octeber 25,	21.8	2.8	13.31	2.0	.000	.002	Very slight trace	Very slight trace.
1268	Well, Bowdoinham	October 25,	25.2	17.0	22.86	.8	.001	.004	Very slight trace	Much.
1269	Well, Milo	October 30,	29.0	12.4	11.80	4.6	.000	.004	Very slight trace	Very much.
1270	Well, Milo	October 30,	27.6	10.0	17.22	4.2	.000	.002	Slight trace	Heavy trace.
1271	Spring, Harrington	October 31,	4.8	3.0	2.34	.6	.000	.000	Trace	Trace.
1272	Well, Harrington	October 31,	3.8	1.2	2.34	.6	.000	.002	Slight trace	Slight trace.
1273	Well, Harrington	October 31,	16.2	6.2	6.71	1.8	.001	.003	Very slight trace	Much.
1274	Spring, Augusta	November 3,	19.2	6.4	11.05	2.0	.000	.000	Slight trace	Very much.
1275	Spring, Searsport	November 4,	11.0	2.4	6.71	.8	.003	.007	Trace	Trace.
1276	Well, Dexter	November 5,	30.2	8.6	13.31	3.0	.000	.004	Trace	Much.
1277	Well, Denmark	November 15,	3.8	2.6	4.57	3.2	.000	.004	Very slight trace	Slight trace.
1278	Well, Oakland	November 6,	16.8	4.6	10.30	2.0	.001	.003	Very slight trace	Heavy trace.
1279	Well, Portland	November 5,	64.4	19.2	17.22	21.2	.012	.002	Very slight trace	Very slight trace.
1280	Spring, Hallowell	November 8,	48.2	13.4	29.68	2.0	.000	.001	Very slight trace	Much.
1281	Well, Cornish	November 12,	4.6	1.4	5.29	.4	.006	.002	Slight trace	Heavy trace.
1282	Well, Sabattus	November 15,	41.6	27.0	15.63	3.4	.167	.015	Much	Very much.
1283	Well, Fryeburg	November 16,	4.2	1.2	7.43	.2	.004	.006	Very slight trace	Very slight trace.

ANALYSES OF SAMPLES OF WATER—EXPRESSED IN PARTS PER 100,000—Concluded.

Number of analysis.	Origin of Sample.	Date of collection.	Total solids.	Loss on ignition.	Hardness.	Chlorine.	Free ammonia.	Organic ammonia.	Nitrites.	Nitrates.
1284	Well, Vienna	November 15,	15.4	5.8	9.57	1.8	.002	.003	Trace	Much.
1285	Well, Brunswick	November 20,	12.6	5.8	6.00	1.0	.000	.002	Trace	Much.
1286	Spring, Portland	November 18,	7.8	4.0	6.43	.4	.001	.002	Very slight trace	Heavy trace.
1287	Spring, Portland	November 18,	4.2	2.8	2.60	.6	.004	.016	Very slight trace	Very slight trace.
1288	Spring, Waterville	November 27,	17.2	3.8	17.22	.3	.003	.000	Trace	Very slight trace.
1289	Well, Waterville	November 23,	17.2	6.8	8.86	2.4	.019	.002	Much	Much.
1290	Well, Freedom	November 22,	6.6	3.2	6.00	.4	.000	.002	Very slight trace	Much.
1291	Spring, Sebago Lake	November 29,	11.8	2.6	10.30	.6	.000	.000	Slight trace	Much.
1292	Spring, Shawmut	November 17,	......	....	4.57	.2	.000	.004	Trace	Very slight trace.
1293	Water supply, Rockland	December 2,	2.2	1.6	2.60	.4	.000	.010	Very slight trace	Very slight trace.
1294	Well, Fairfield	December 10,	23.8	8.4	17.22	.6	.007	.003	Much	Much.
1295	Spring, Augusta	December 13,	20.4	8.6	13.31	2.2	.132	.054	None	Much.
1296	Spring, Augusta	December 13,	21.4	6.4	12.56	2.0	.001	.001	None	Much.
1297	Spring, Waterville	December 28,	9.2	4.2	6.71	.3	.000	.001	Very slight trace	Heavy trace.

NOTES ON SOME OF THE SAMPLES OF WATER EXAMINED IN THE LABORATORY.

No. 1,066. "The water is seriously polluted. I should not consider it a safe source for a drinking supply. It may, of course, be used for any domestic purpose after it is boiled, as in making tea or coffee, but for this purpose as well as for general domestic use it is too hard a water. It is an exceedingly hard water."

No. 1,069. From a well three hundred feet distant, or farther from possible sources of pollution. "The chemical results show that this is a very good and pure water for drinking purposes. A further advantage, both as a drinking water and in domestic use generally, is that it is quite a soft water for a well water. Its degree of hardness as you will notice on the back of this sheet, is only 2.60. The river waters generally in this State are a little less than 2.00."

No. 1,073. "The results indicate a water neither very good nor very bad. There is a slight degree of pollution, and the most that can be said of this is that it renders the water suspicious. It was a mistake to bury the contents of the vault so near the well. Seventy-five feet is altogether too near for safety, particularly when the soil is underlaid by a stratum of clay at the bottom of the well. With that arrangement of things polluting matter sometimes finds its way into wells from a much greater distance than seventy-five feet.

"I would advise you next spring to again clean out the privy very thoroughly, and pour into the vault a large quantity of 'milk of lime.' Milk of lime is to be made just as you make whitewash, slaking newly burnt lime; pour in a very large quantity of it, using a hoe, or other tool after it is poured in for the purpose of stirring up the soil all over the bottom of the

vault, and thus bringing the milk of lime into contact with the ground as thoroughly as possible.

"Some authorities have recommended the same methods for disinfecting wells when there is a suspicion that they have become infected. Of course that must be done after the water has been pumped out, or drawn out from the well as dry as possible, and a large quantity of the milk of lime would have to be turned in and stirred up thoroughly from the bottom of the well as the water again rose.

"If you were to apply this treatment to the well, it would require a barrel of lime, at least. That would disinfect the well, but, of course, if the well received infection from the place where you buried that matter, it would not bar the possibility of a reinfection from the same source.

"To determine whether there is any soakage into the well from the place where you buried the excreta, I would suggest that next summer you dig a hole in the same place where you buried the deposit and pour in a large quantity of the solution of lysol. If there is a soakage into the well from that place, you would be likely to have, some time after, the taste of lysol in the water. It would be an interesting experiment to try, and if you will do it, I will furnish you with the lysol next summer."

No. 1,078. The following is written in reply to an application for an analysis of a spring water which was under suspicion of pollution from a cemetery:

"I will send a bottle to you to-day or to-morrow by American Express. Quite a number of pieces of work have been done within a few years for the purpose of determining the effect of the proximity of burying-grounds upon wells and springs. The most of this work is rather disappointing to those who expected to find that the waters are invariably or usually badly affected. These works serve to strengthen confidence in the filtering and oxidizing capacity of the soil, particularly of soil of certain kinds."

The report upon the results of the analysis says: "I think I wrote to you that the polluting effects of cemeteries have often been found to be less than was expected. In the case of this water, however, in the absence of any other apparent source of pollution, the indications are that the burying-ground has an

unfavorable influence upon this spring. Still the degree of impurity is only moderate. From the history of the location of the spring and the cemetery, I should deem this spring an unsuitable place from which to obtain drinking water. I should think the chances are that at times it might be affected more than is shown in this sample. I do not see how anybody who knows its source can drink this water."

The history of the relative location of the spring and burying-ground shows that the spring was only twenty or thirty feet from the burying-ground; that the bottom of the spring was ten or twelve feet lower than the surface of the burying-ground; that there were three or four feet of sand with a clay substratum; and that there had been many burials in the part of the cemetery next to the spring.

No. 1,079. Sample taken from a spring five hundred feet from the seashore and ten feet above the sea level. "This is a very good, pure spring water and in every way suitable for a drinking supply. It is also quite soft for a spring water, and this character renders it still more desirable as a drinking supply."

No. 1,080. From a well much too near sources of pollution. There had been cases of typhoid fever in the family. "The analysis of the sample of water which you sent a while ago, indicates results which could hardly be worse. The water is badly polluted and should not be used as a drinking water. By using it there will be a great danger of recurring outbreaks of typhoid fever among the consumers of the water."

No. 1,086. From a well from twenty-five to forty-six feet distance from cesspool, sink drain, and privy. The soil is sand for eight feet with an underlying stratum of clay. "The condition of the surroundings of the well are unfavorable, and the analysis shows that the water is polluted. It is also too hard a water to be a desirable drinking water even if no pollution were present. I would advise the discontinuance of the use of the water for a drinking supply. There is, however, no objection to its use for domestic purposes after it is boiled."

No. 1,087. "The analysis shows it to be a good and pure spring water. The figures obtained in the analysis are shown upon the accompanying sheet." This sample was taken from

a spring fifty rods distant from farm buildings and all possible sources of pollution.

No. 1,090. "You will note that the water is an exceedingly hard water. I think that no sample of water with a higher degree of hardness has ever been received in this office. The degree of hardness of the Kennebec river water averages a little less than 2.00. The hardest waters usually come from the limestone regions of Aroostook county, and from around Rockland and Thomaston. The hardness of water from those localities is usually indicated by figures well up to, or into the twenties; rarely up to 30.00. The degree of hardness of this water is more than 45.00.

"The work done in this office is principally in the direction of determining the purity of water supplies and their suitability for drinking, but, without much experience in determining the suitability of samples of water for use in boilers, I should suppose that this, with so large a total of solids and with so extreme a degree of hardness, would be altogether unsuitable for use in boilers. Its hardness makes it an undesirable water for drinking. It has also a large excess of free ammonia and of chlorine which, in waters from ordinary sources, are considered as evidences of pollution, but which in waters from so deep a source do not so conclusively establish that fact."

No. 1,091. A well where there had been eight cases of typhoid fever; the distance of possible sources of pollution from one hundred and thirty to two hundred feet. "Chemically, this sample is a well water of good quality, but this fact does not prove conclusively that the water had nothing to do with the origin of the cases of fever last fall. The well and its water may have then been in a worse condition, and probably was, as you state it has since been cleansed and a new pump put in. It is a hard water, its degree of hardness being about like that of the average well water from Aroostook county."

Nos. 1,099, 1,100, and 1,101. "I herewith report on the samples which you sent to this office June 8th. The figures obtained are shown on the back of this sheet.

"Analysis No. 1,099; sample from Sabattus pond. Your No. 1 in bottle 124. It contains a much larger quantity of organic matter than is to be found in any public water supply in the

State. I should fear that at times, particularly in warm weather, this water would develop offensive tastes and smells. It may be, however, that this sample was improperly taken. If you should use this pond as a source of supply your in-take would, or at least should be, taken from a point where the shore is hard and clean, as remote as practicable from swampy or mucky ground or excessive vegetation in the pond, and where the water is of considerable depth. I know nothing about the condition of things where this sample was taken. Your engineer is the proper person to determine from what point samples should be taken. If you wish to try again from this pond, I will send you other bottles.

"No. 1,100—Bangs Spring, in bottle 39, your No. 2. No. 1,101—Lombard Spring, in bottle 119, your No. 3. There is no practical difference in the quality of these two waters. They are both chemically good and pure waters. The choice between them should depend upon the comparative abundance of flow, chances of future pollution, etc. Both of these waters are quite soft for spring waters,—slightly softer than the pond water.

"But when the object which applicants for analyses have in view is a suitable source for a public water supply, I have to caution strongly against basing the decision wholly or too strongly upon the results of the chemical analysis, especially when there has been but a single analysis made, or several analyses extending over only a brief period of time. Many of the questions which should have a bearing upon the choice of the source can be most properly considered and determined by an engineer who has had experience in work of this kind. It is desirable, of course, to have a soft water, and so far as the public health is concerned, it is still more important to make a careful investigation of the likelihood, present and future, of sources of pollution upon the watershed."

No. 1,109. From a well eighteen feet deep with evidences of sources of pollution from thirty to forty feet distant. "The analysis shows that the water is badly polluted. It is also a very hard water. It happens quite frequently, as appears to have been the case with your well, that a well with unfavorable surroundings furnishes water of good quality for some years, and sometimes for many years, but that finally, after the line of

soil pollution has gradually extended from the various sources of pollution, it reaches the well, and the well henceforth ceases to yield water suitable for drinking. You appear to have made some improvements lately, but I should think it quite likely that with any changes you might make, it would take the soil surrounding the well sometime to purify itself so that the well will not be polluted from it."

No. 1,110. A spring water brought twenty-five rods through lead pipe, constantly running. "The analysis of the sample of water shows that it is good and pure, with the exception that it contains a slight trace of lead. The water has proved so good that it is a pity to have anything in connection with it casting suspicion on its healthfulness. If you wish me to do so, I will test the water for lead a few times more to see whether the lead is constantly present. You can send the samples at any time you choose, at intervals I would suggest, and some weeks apart."

No. 1,120. A drilled well fifty feet deep, with the sink drainage twenty feet, and the privy fifty feet distant. "The analysis of the sample of water sent by you a little while ago, shows it to be a water of medium quality, neither very good nor very bad. There is a slight excess of organic matter, but not enough so that I could say that the water is unsuitable or unsafe for drinking purposes. It is a hard water, but its degree of hardness is not so great as that of the waters from many of the Aroostook wells.

"You referred to the possibility of there being seams in the rock. The limestone ledges in Aroostook, even while they appear to be quite solid, are invariably traversed with fissures; these will sometimes conduct polluting matter long distances into wells. I would, therefore, advise you not to trust anything whatever to the fact that it is a drilled well. It will be much safer to have the construction and management of the privy such that there can be no possibility of soakage into the ground from that source. The danger from the sink drainage should also be borne in mind, and the waste from this source should be disposed of as far as possible from the well. With precautions in these directions, I should think the water might remain good."

Nos. 1,129 and 1,130. These two samples of spring water were brought from a spring through thirty-five rods of lead pipe. There had been symptoms of lead poisoning in the family. "Both samples of water which you sent contain a large quantity of lead, enough to make the use of the water dangerous whether for drinking or for cooking. With the symptoms of lead poisoning which have already occurred, it would be very unwise to continue the use of the water either as an occasional or a constant supply. With the exception of the presence of lead, the water is a very good and pure spring water. It is, moreover, quite a soft water for a spring water and it is, therefore, more likely to dissolve the lead of the pipe through which it flows."

No. 1,149. A well ten feet deep. The sink drain being ten feet and the privy thirty-nine feet distant. There had been cases of typhoid fever in the family. "The chemical results are not unfavorable. Pollution of the water is not shown. Nevertheless, for the reason that the well is not a deep one, that it goes down to a ledge, and that the sources of pollution are much too near, we would not be justified in concluding that it is impossible for the well water to be polluted at times. I should indeed fear that it is. There would be greater danger of infection now since you have had cases of typhoid fever at your home. If there is any possibility that the privy vault was infected, or that the cesspool into which the sink drainage discharges received the germs of typhoid fever from infected washing water, or otherwise, these two places should be thoroughly disinfected. The cheapest and most efficient method of disinfection would be to run into them a large quantity of milk of lime made from perfectly fresh caustic lime slaked and diluted with water, just as you would make whitewash. Pailful after pailful of this milk of lime should be poured into the privy so that the whole contents of the vault and the ground beneath may be saturated. After the contents are removed, the ground should again be saturated with the milk of lime. You should use at least a bushel of the lime in the process.

"If you are to continue to use the water in the future, the privy should be removed much farther away, or it should be so constructed and managed that there can be no soakage into the ground of foul matter from it.

"Any suspected well water is perfectly safe to use for all purposes after it is boiled, for example, in making tea and coffee. The analysis of the sample shows that the water was chemically good when the water was taken. I urge the precautions on account of the character of the well and its surroundings, and because I fear there is danger at any time of pollution and infection. I send you a copy of the Eighth Annual Report. Please read what is said on page 24 and the few following pages."

No. 1,163. A spring water brought through twelve hundred feet of lead pipe. "The analysis of the sample shows that it is a good and pure water for drinking with the exception that it contains a heavy trace of lead, enough to render the use of the water dangerous."

No. 1,164. A drilled well or spring nine feet deep. "I am glad to be able to report that the results of the analysis show that the spring furnishes a very good and pure water excellent in every way as a drinking supply."

No. 1,174. "The cellar is not a good place for a well, but in the case of yours the chemical analysis shows that it is a good and pure water. From your description of the conditions, I should think that the water comes from below a layer of clay and is, therefore, not so likely to be polluted as it would be if the conditions were otherwise."

No. 1,178. A driven well eighteen feet deep. "The analysis of the sample of water shows that it is good and pure. It is also quite soft for a well water and that renders it more desirable for drinking."

No. 1,182. A well thirty feet deep. Twenty feet from the privy with other possible sources of pollution still nearer. "The chemical analysis of the sample of water which you sent shows that it is very badly polluted and is undesirable for drinking."

No. 1,194. A spring three hundred feet from sources of pollution. "This is a very good and pure water and in every way suitable as a drinking supply. It is, moreover, quite a soft water and this also makes it more desirable as a drinking water, and is an advantage otherwise."

No. 1,195. A spring with probable sources of pollution from one hundred to two hundred feet distant. The ground is sandy

and gravelly to a depth of from four to six feet with an underlying deep and impermeable stratum of clay. The report said: "The results show that it is quite seriously polluted. The degree of pollution is sufficient so that I should deem the water unsafe for drinking in an unboiled condition. From your description of the surroundings, it appears that there is no source of pollution very near, but we find, in many cases where the conditions are such as you state with reference to the character and thickness of the successive layers of earth, that the impermeable stratum of rock or clay at a rather slight distance below the surface serves to run the polluting matter into wells from distances sometimes more than one hundred or two hundred feet. I think you are right in suggesting that the clay bottom which extends under the whole town has something to do with the pollution of this spring."

No. 1,214. A sample of water from the outlet of Tuft's pond. "The chemical results are very favorable, and indicate a water suitable in every way as a public water supply. If this one sample indicates the constant condition of the water, it is as good as any, so far put in, in the State.

"The advice of this Board has been not to depend upon a single analysis when it is sought to determine whether a proposed source is suitable as a public water supply, but to have the analyses cover as much time as possible before the source of supply is determined. Neither should the determination of the source of supply be settled by chemical analysis alone, but, in all cases, an expert authority should be engaged to make an examination of the character of the pond or other proposed sources, of the watershed, and, particularly, whether there are any present or prospective sources of pollution, particularly with animal organic matter. Human excreta as it comes from sewers and privies is, of course, the most dangerous kind of polluting matter."

Nos. 1,219 and 1,220. "Reporting on the two samples of spring water which you sent June 22, I would say that the results show practically no difference between them. They are enough alike to have come from the same spring. They are both good and pure drinking waters."

No. 1,226. A well thirty-three feet deep with the privy, sink drainage, pig-pen, and barn-yard from forty to seventy-five

feet from the well. "The analysis shows that there is a moderate degree of pollution. Though the degree of pollution is not large, I should deem the well an unsafe source from which to obtain a drinking supply, particularly now, since typhoid fever has been in the family. The possible sources of pollution, the privy, sink drain, etc., are much too near for safety, and after the ground about a well has once been infected with the germs of typhoid fever, there is no knowing how long this infection of the ground may endanger the well.

"Of course, so far as infection is concerned, all danger is removed by boiling the water. The water from this well, therefore, may be used for many domestic purposes, but that part of the drinking supply which is to be consumed, unboiled, should be obtained from some other source."

No. 1,234. A well in the thickly settled part of the city. "The analysis gives unfavorable results, but the water is polluted in a medium degree. The source of pollution is not apparent in the description of the surroundings of the well, but it is undoubtedly due to the general pollution which is found in the soil of thickly built portions of a city. The water is rendered still further undesirable on account of its hardness and large quantity of total solids,—earthy matter."

No. 1,236. "Basing my opinion upon the results of a single analysis, I could not pretend to pronounce positively in regard to the suitability of Moose Hill lake as the source of a public water supply, for the reason that the character of the water from some sources has quite considerable seasonal fluctuations. Neither does this Board advise the use of the results of even a series of analyses as the basis for a decision of the suitability of a given water as a source of supply. In addition to what may be learned from the chemical results, a careful inspection should be made by a person who is trained in this sort of work for the purpose of determining the character of the soil, of the vegetation of the watershed, and of the possibilities of pollution, present and prospective.

"As to the results obtained in the analysis of the sample of water set by you, August 3, I will say that they are favorable and indicate a pond or lake water of good quality. The quantity of total solids is small. It is quite a soft water; its degree

of hardness being about the average of that of the principal river waters in Maine, 1.95. The quantity of organic matter in the water is not large, though not so small as is found in some of the supplies in the State taken from lakes and ponds.

"Some water supplies, taken from lakes and ponds, are sometimes troubled, more frequently in warm weather, with unpleasant tastes and smells dependent upon the growth in the water of microscopic vegetation. Whether this might ever occur in this water, I am unable to tell you. It is not so likely to occur in waters taken from lakes with clean, rocky or pebbly shores as in those which come from bodies of water with swampy or muddy bottoms.

"The preferable way would have been to have had a series of chemical examinations covering, preferably, a whole year."

No. 1,241. A spring one-half mile from all possible sources of pollution. "The analysis shows it to be a water of excellent quality for drinking. The figures obtained in the examination are given upon a separate sheet."

No. 1,242. A driven well. "A water of excellent quality for drinking. It moreover has the advantage of being unusually soft for a well or spring water."

No. 1,284. From a well twenty-three feet deep, dug for most of that depth through a limestone ledge standing edgewise. The privy, stable, and cesspool are from forty-seven to one hundred seventeen feet from the well. "The results indicate a water neither very good nor positively bad. Though the evidences of pollution are slight, my judgment is that the well feels in a slight degree the influence of the polluting matter from some of the surrounding sources. There is much more danger of the pollution of wells that are dug down to or into ledges, particularly ledges of the kind which you describe, than there is in most other wells.

"My advice, therefore, would be for the families who have been using this water to obtain from some other source that part of their drinking supply which is to be used unboiled, if that is practicable. For all ordinary domestic purposes, cooking, making tea, coffee, etc., there could be no objection to the use of this water save its hardness."

ADDITIONS TO THE LIBRARY.

During the years 1896 and 1897 the following books, pamphlets, and journals were added to the library of the Board by exchange and by purchase.

BOOKS.

Althaus. On failure of Brain Power. London. 1894.
Bartholmew. The Globe Hand Atlas. New York.
Billings. Vital Statistics of the District of Columbia and Baltimore. Washington. 1893.
Dukes. Work and Overwork in Relation to Health in Schools. London. 1893.
Hazen. The Filtration of Public Water Supplies. New York. 1895.
Holman. Computation Rules and Logarithms. New York. 1896.
Ingraham. Don'ts for Consumptives. 1896.
Jaruntowsky. The Private Sanatoria for Consumptives. London.
Mason. Water Supply. New York. 1897.
McDowall. Weather and Disease. London. 1895.
Rideal. Water and Its Purification. London. 1897.
Rotch. Pediatrics. The Hygienic and Medical Treatment of Children. Philadelphia. 1896.
Sternberg. A Manual of Bacteriology. New York. 1892.
Thresh. Water and Water Supplies. Philadelphia. 1896.
Vaughan and Novy. Ptomaines andLeucomaines. 1896.
Woodhull. Military Hygiene. New York. 1890.
Worcester. Small Hospitals. Establishment and Maintenance. New York. 1894.
Blattern und Schukpockenimpfung. Berlin. 1896.
Die Berliner Volkszahlung von 1890.
Esmarch. Hygienisches Taschenbuch. Berlin. 1896.

Guinochet. Les eaux D'Alimentation, Epuration, Filtration et Sterilisation. Paris. 1894.

Handbuch der Klimatischen Heilkunde. Berlin. 1892.

Labit et H. Polin. L'Hygiene Scolaire. Paris. Vols. I and II.

Léon-Petit. Le Phtisique et son Traitement Hygiénique. Paris. 1895.

Magelssen. Ueber die Abhangigkeit der Krankheiten von der Witterung. Leipzig. 1890.

Miquel. De la Désinfection des Poussiéres Séches des Apartments. Paris. 1895.

Strumpell. Die Padagogische Pathologie. Leipzig. 1892.

Weyl. Handbuch der Hygiene. Heizung und Ventilation. Jena. 1896.

Weyl. Handbuch der Hygiene. Die Schicksale der Fakalien Rieselfelder. Jena. 1896.

Weyl. Handbuch der Hygiene. Gewerbehygiene. Jena. 1896.

Weyl. Handbuch der Hygiene. Wasserversorgung, Untersuchung und Beurteilung. Jena. 1896.

Weyl. Handbuch der Hygiene. Netolitzky. Hygiene der Textilindustri Medizinal-Statistische Mittheilungen aus dem Kaiserlichen Gesundheitsamte. Berlin. 1897.

Statistisches Jahrbuch der Stadt Berlin. 1894.

Hamlin. Maine Reports. Vol. 8.

Statutes of Maine. Freeman's Supplement. 1885-1895.

Index Catalogue of the Library of the Surgeon-General's Office. Second Series. Vol. I. 1896.

Abstract of the Eleventh Census. 1890. Washington. 1896.

Eleventh Census of the United States, 1890. Vital and Social Statistics. Parts I, II, III, IV.

Eleventh Census of the United States, 1890. Crime, Pauperism and Benevolence. Part II.

Eleventh Census of the United States, 1890. Farms and Homes.

U. S. Department of Agriculture. Jordan. Dietary Studies at the Maine State College in 1895. Washington. 1897.

U. S. Department of Agriculture. Cornstalk Disease and Rabies in Cattle.

U. S. Department of Agriculture. Texas Cattle Fever. Washington. 1893.

Statistical Report of the Health of the Navy. London. 1894.

Addresses, Papers and Discussions in the Section of State Medicine of the American Medical Association. Atlanta. 1896.

Transactions of the American Climatological Association. Vols. 10, 11, 12.

Transactions of the New Hampshire Medical Society. 1895. 1897.

Proceedings at the Tenth and Eleventh Meetings of the National Conference of State Boards of Health.

REPORTS.

California. Fourteenth Biennial Report of the State Board of Health. 1894-96.

Connecticut. Eighteenth Annual Report of the State Board of Health. 1895.

Delaware. Ninth Biennial Report of the State Board of Health. 1896.

Illinois. Eighteenth Annual Report of the State Board of Health. 1895.

Indiana. Fifteenth Annual Report of the State Board of Health. 1896.

Iowa. Eighth Biennial Report of the State Board of Health. 1894-95.

Kansas. Eleventh Annual Report of the State Board of Health. 1895.

Maryland. Eleventh Biennial Report of the State Board of Health. 1894-95.

Massachusetts. Twenty-seventh Annual Report of the State Board of Health. 1895.

Massachusetts. Fifty-third Report on Births, Marriages and Deaths. 1894.

Michigan. Twenty-first Annual Report of the State Board of Health. 1893.

Michigan. Twenty-second Annual Report of the State Board of Health. 1894.

Michigan. Twenty-eighth Annual Report on Births, Marriages and Deaths. 1894.

New Hampshire. Fourteenth Report of the State Board of Health. 1895-96.

New Jersey. Nineteenth Annual Report of the State Board of Health. 1895.

New Jersey. Twentieth Annual Report of the State Board of Health. 1896.

New York. Fifteenth Annual Report of the State Board of Health. 1894.

New York. Sixteenth Annual Report of the State Board of Health and Maps. 1895.

North Carolina. Sixth Biennial Report of the State Board of Health. 1895-96.

Ohio. Tenth Annual Report of the State Board of Health. 1895.

Oklahoma. Biennial Report of the Territorial Board of Health. 1895-96.

Pennsylvania. Eleventh Annual Report of the State Board of Health. 1895.

Pennsylvania. Twelfth Annual Report of the State Board of Health. Vols. I and II. 1896.

Rhode Island. Seventeenth Annual Report of the State Board of Health. 1894.

Rhode Island. Forty-second Registration Report. 1894.

Rhode Island. Forty-third Registration Report. 1895.

South Carolina. Sixteenth Annual Report of the State Board of Health. 1895.

South Carolina. Seventeenth Annual Report of the State Board of Health. 1896.

Vermont. Thirty-eighth Report on Births, Marriages, Deaths and Divorces. 1894.

West Virginia. Biennial Report of the State Board of Health. 1895-96.

Wisconsin. Sixteenth Report of the State Board of Health. 1895-96.

British Columbia. First Report of the Provincial Board of Health. 1895.

British Columbia. Second Report of the Provincial Board of Health and Supplement. 1896.

New Brunswick. Ninth Annual Report of the Provincial Board of Health. 1895.

New Brunswick. Tenth Annual Report of the Provincial Board of Health. 1896.

Nova Scotia. Fourth Annual Report of the Provincial Board of Health. 1896.

Ontario. Fourteenth Annual Report of the Provincial Board of Health. 1895.

Ontario. Report on Births, Marriages and Deaths. 1895.

Quebec. Second Annual Report of the Provincial Board of Health. 1895-6.

England. Fifty-seventh Annual Report of the Registrar-General of Births, Deaths and Marriages. 1894.

Ireland. Thirty-second Annual Report of the Registrar-General. 1895.

Scotland. Forty-first Annual Report of the Registrar-General. 1895.

Rapport presente au Conseil Communal Bruxelles. 1896.

Boston, Mass. Twenty-fourth Annual Report of the Health Department. 1895.

Calcutta. Reports of the Health Officer for 1894 and 1895.

Chicago, Ill. Biennial Report of the Department of Health. 1895-96.

Concord, N. H. Annual Report of the Sanitary Department. 1896.

Denver, Colo. Annual Report of the Bureau of Health. 1896.

Glasgow. Twenty-sixth Annual Report of the Sanitary Department. 1895.

Lowell, Mass. Nineteenth Annual Report of the Board of Health. 1896.

Lynn, Mass. Annual Report of the Board of Health. 1896.

Manchester, N. H. Report of the Board of Health. 1896.

Memphis, Tenn. Eighteenth Annual Report of the Board of Health. 1896.

New Haven, Conn. Report of the Health Department. 1896.

Newport, R. I. Tenth Annual Report of the Board of Health. 1896.

Oberlin, Ohio. Fifty-first Annual Report of Village. 1897.

Providence, R. I. Fourteenth Annual Report of the Superintendent of Health. 1896.

Providence, R. I. Annual Reports of the City Engineer for 1895 and 1896.

Providence, R. I. Forty-first Annual Report of Births, Marriages and Deaths. 1895.

San Francisco. Report of the Health Department of the City and County. 1895.

St. Louis. Eighteenth Annual Report of the Health Commissioner. 1895.

St. Louis. Nineteenth Annual Report of the Health Commissioner. 1896.

St. Paul. Annual Report of the Health Commissioner. 1896.

Winona, Minn. Annual Report of the Board of Health. 1897.

Annual Report of the Supervising Surgeon-General of the Marine Hospital Service. 1895. 1896.

Sixth, Seventh, and Eighth Annual Reports of the Metropolitan Sewerage Commission. 1896.

Cattle Commissioners Report of Massachusetts. 1894-95-96.

Tenth and Eleventh Annual Reports of the Bureau of Animal Industry. Washington. 1893-94.

Twelfth and Thirteenth Annual Reports of the Bureau of Animal Industry. Washington. 1895-96.

Report of Commissioners on Contagious Diseases of Animals. 1896.

Report of Dairy Commissioner of New Jersey. 1895 and 1896.

Special Report of the Board of Health upon the Cholera Epidemic in Honolulu, Hawaiian Islands, in August and September. 1895.

Sixth Annual Report of Board of State Assessors. Maine. 1896.

Maine School Report. 1896.

Report of the Committee on International Quarantine adopted by the Pan-American Medical Congress, held in the city of Mexico, Nov. 16-19, 1896.

Report of the Royal Commission on the Effect of Food Derived from Tuberculous Animals on Human Health.

Report on the Heating and Ventilation of the Senate Wing of the United States Capitol, Washington, D. C. 1895.

Report of the Tenth Annual Meeting of the American Association for the Advancement of Physical Education. New York. 1896.

Pamphlets.

Bachelder. Causes and Conditions which Develop Bovine Tuberculosis. Bulletin of the State Board of Agriculture of Maine. 1897.

Baker. The Removal of Iron from Ground Water.

Burroughs. Management and Treatment of Tuberculosis in the Asheville Climate with Report of Cases. 1896.

Canalis. Esperienze sugli Apparecchi di Disinfezione a Vapore. Roma. 1895.

Cary. Meat Inspection. Alabama Agricultural Experiment Station.

Chalmers. A New Life Table for Glasgow. 1881-1890.

Duke. A Handbook on Disinfection. Cumberland, Md. 1893.

Frölich. Des Soldaten Gesundheitsbuchlein. Leipzig. 1893.

Gibson, Calvert and May. Dietary Studies at the University of Missouri in 1895. Washington. 1896.

Goss. Dietary Studies in New Mexico in 1895.

Hartwell. Report of Director of Physical Training. Boston. 1895.

Johnston and McTaggart. On the Difference between Serum and Blood Solutions, etc. 1897.

Knopf. Should we treat Pulmonary Tuberculosis as a Contagious or as a Communicable Disease. 1896.

Palmer. Chemical Survey of the Water Supplies of Illinois.

Penney. Milk-Sampling. Bulletin of the Delaware College of Agriculture. Newark, Delaware.

Rafter. On Lake Erie as a Water Supply for the Towns on its Borders.

Russell. The Evolution of the Function of Public Health Administration. Glasgow. 1895.

Russell. The Modern Doctrine of Tuberculosis. Glasgow. 1896.

Russell. On the Prevention of Tuberculosis. Glasgow. 1896.

Staples. Concerning the Present Condition of State Medicine in the United States. 1897.

Trillat. La Formaldéhyde et ses Applications Pour la Désinfection des Locaux Containés. Paris. 1896.

Wilson. A Contribution to the Natural History of Scarlet Fever. London. 1897.

Woodbridge. Ventilation of School Buildings.

Woodbridge. Hygienic Condition of the Public School Buildings of Philadelphia. 1897.

Wyman. Bubonic Plague. Malignant Polyadenitis.

A Precis of Quarantine Practice at National Quarantine Stations.

Cremation—Disinfection—Sterilization.

How Hotel Keepers can aid in Preventing the Spread of Tuberculosis.

How Persons Suffering from Tuberculosis can avoid giving the Disease to Others.

How Dangerous Communicable Diseases are Spread and how Restricted. Michigan Board. 1896.

Inspections of National, State and Local Quarantine Stations.

Glasgow Health Committee. Prevention of Consumption.

Glasgow Health Committee. Prevention of Measles.

Pennsylvania State Board of Health Circulars. Precautions against Whooping Cough.

Pennsylvania State Board of Health Circulars. Precautions against Measles.

Pennsylvania State Board of Health Circulars. Suggestions on Railroad Hygiene.

Purdue University Monographs. Series relating to Public Health. Nos. 3, 4, 5. 1896.

Annuaire Démographique et Tableaux Statistiques des Causes de Décés. Bruxelles. 1896.

Transactions of the Rhode Island Medical Society. Vol. V. Part I. 1895.

Proceedings of the Thirteenth Annual Convention of the National Confectioner's Association. Cleveland. 1896.

Proceedings at the National Conference of State Boards of Health. 1894, 1896.

Proceedings at the Twenty-first Annual Meeting of the New Jersey Sanitary Association. 1895.

Anleitung für den Gebrauch des Abessinischen Brunnens. Berlin. 1893.

Weston. Report of the Results Obtained with Experimental Filters. Providence, R. I. 1896.

Sanitary and Other Journals.

The Sanitarian. Brooklyn, N. Y. 1896-97.
The Annals of Hygiene. Philadelphia. 1896-97.
The Engineering Record. New York. 1896-97.
The Sanitary Record. London. 1896-97.
The Boston Medical and Surgical Journal. Boston. 1896-97.
Architecture and Building. New York and Chicago. 1896-97.
Brooklyn Medical Journal. Brooklyn, N. Y. 1896-97.
Medical News. Philadelphia. 1896-97.
Medical Times. New York. 1896-97.
Medical Standard. Chicago. 1896-97.
The Pittsburgh Medical Review. Pittsburgh. 1896-97.
The Microscope. Washington. 1896-97.
The American Monthly Microscopical Journal. Washington. 1896-97.
Modern Medicine and the Bacteriological Review. Battle Creek, Mich. 1896-97.
Occidental Medical Times. Sacramento. 1896-97.
The Journal of Experimental Medicine. New York. 1897.
The Therapeutic Gazette. Philadelphia. 1897.
The Universal Medical Journal. Philadelphia. 1896-97.
The American Journal of the Medical Sciences. Philadelphia. 1897.
Public Health. Philadelphia. 1896-97.
The Medical World. Philadelphia. 1896-97.
The Municipality and County. Buffalo, N. Y. 1896-97.
The Health Magazine. Washington. 1896-97.
Journal of Medicine and Science. Portland, Me. 1896-97.
Lehigh Valley Medical Magazine. Easton, Pa. 1896-97.
The Virginia Medical Semi-Monthly. Richmond. 1896-97.
Columbus Medical Journal. Columbus, Ohio. 1896-97.
Journal of the American Public Health Association. Concord, N. H. 1896-97.
Journal of the New England Water Works Association. New London, Conn. 1896-97.
The Philadelphia Polyclinic. Philadelphia. 1896.
Monthly Report of Climate and Crop Service. Boston. 1896-97.
Monthly Bulletin of the Iowa State Board of Health. Des Moines. 1896-97.

Bulletin of the State Board of Health of Tennessee. Nashville. 1896-97.

Bulletin of Board of Health of Louisiana. New Orleans. 1896-97.

Bulletin of the North Carolina Board of Health. 1896-97.

Bulletin of the Virginia Board of Health. Richmond. 1896-97.

Monthly Bulletin of the State Board of Health of Rhode Island. 1896-97.

Monthly Sanitary Record, State Board of Health of Ohio. 1896-97.

The Vermont Medical Monthly. Burlington. 1896-97.

Florida Health Notes. 1896-97.

The Municipal World. St. Thomas, Ont. 1896-97.

Public Health Reports. Washington, D. C. 1896-97.

The Journal of State Medicine. London. 1896-97.

Public Health. London. 1896-97.

The Lancet. London. 1896-97.

Index Medicus. Detroit and Boston. 1896-97.

Revue D'Hygiene. Paris. 1896-97.

Archiv für Hygiene. Munich and Leipzig. 1896-97.

Zeitschrift für Hygiene. Berlin. 1896-97.

Deutsche Vierteljahrsschrift für Offentliche Gesundheitspflege. Braunschweig. 1896-97.

Deutsche Medicinische Wochenschrift. Berlin. 1896-97.

Zeitschrift für Schulgesundheitspflege. Hamburg. 1896-97.

Arbeiten aus dem kaiserlichen Gesundheitsamte. Berlin. 1896-97.

Centralblatt für Bakteriologie und Parasitenkunde. Jean. 1896-97.

Gesundheits-Ingenieur. Munchen. 1896-97.

Veröffentlichungen des kaiserlichen Gesundheitsamtes. Berlin. 1896.

Schweizerische Blätter für Gesundheitspflege. Zurich. 1896-97.

Giornale della Reale Societa Italiana D'Igiene. Milano. 1896-97.

La Salute Pubblica. Perugia. 1896-97.

Bulletin de L'Institut International de Statistique. Vols. VIII and IX.

Boletin del Consejo Superior de Salubridad. Mexico. 1896-97.

ABSTRACTS FROM THE REPORTS OF THE LOCAL BOARDS OF HEALTH.

ABBOT. One nuisance removed. One case of typhoid fever in 1897. No infectious diseases in 1896.—D. M. Kimball, Sec.

ACTON. 1896. One case of typhoid. 1897. One nuisance removed. No infectious outbreaks.—B. J. Grant, Sec.

ADDISON. 1896. Four cases of typhoid fever. 1897. One of the same disease. Measles in September. Tuberculous sputum was disinfected.—N. W. Curtis, Sec.

ALBANY. 1896. Two cases of diphtheria in one house. Whooping cough in September. 1897. No infectious diseases. Vaccination in March.—G. W. Beckler, Sec.

ALBION. 1896. One nuisance removed. Two cases of diphtheria, three of scarlet fever, and two of typhoid.—F. E. Withee, Sec. 1897. No infectious diseases except measles.—Wm. H. Tukey, Sec.

ALEXANDER. 1896. One case of typhoid fever. The year has been very healthful. 1897. No infection.—A. H. Perkins, Sec.

ALFRED. 1896. One nuisance removed. One case of typhoid. 1897. One nuisance removed. Two cases of diphtheria, treated with quarantine, antitoxin, and disinfection.—C. E. Lander, Sec.

ALNA. No cases of infectious disease in either year.—A. B. Erskine, Sec.

ALTON. 1896. Two cases of typhoid. 1897. No infectious diseases.—H. L. McKechnie, Sec.

AMITY. One nuisance removed. No infectious outbreaks in either year.—Geo. E. Nickerson, Sec.

ANDOVER. The two years have been free from infectious diseases.—Geo. O. Huse, Sec.

ANSON. One case of typhoid occurred in each year, but no diphtheria or scarlet fever. Two nuisances were removed.—Geo. F. Newell, Sec.

APPLETON. 1896. One case of typhoid fever.—S. B. Ripley, Sec. 1897. No outbreaks reported.—G. B. Thompson, Sec.

ARGYLE. 1896. One nuisance removed. Only one case of whooping cough. 1897. Three nuisances removed. One case of typhoid fever.—J. W. Freese, Sec.

ARROWSIC. No infectious diseases in either year.—J. McFadden, Sec.

ASHLAND. 1896. Two nuisances removed. Eighteen cases of scarlet fever in four houses.—Dr. H. L. Dobson, Sec.

ATHENS. 1896. One nuisance removed. No cases of diphtheria, scarlet fever, or typhoid. Whooping cough in the fall. 1897. One nuisance removed. Seventeen cases of scarlet fever and one of typhoid. Tuberculous sputum is disinfected or burned.—L. N. Ellingwood, Sec.

ATKINSON. 1896. No cases reported.—Geo. D. Lyford, Sec. 1897. No infectious outbreaks.—J. C. Campbell, Sec.

AUBURN. 1896. Twenty nuisances were reported, all of which were removed. Seven cases of diphtheria, forty-three of scarlet fever, and seven of typhoid fever. 1897. Ten nuisances removed. Eighteen cases of diphtheria, forty of scarlet fever, and eight of typhoid. In connection with cases of tuberculosis the importance of cleanliness and the care of sputum was impressed. This board has a regular weekly meeting.—Dr. A. M. Peables, Sec.

EXTRACT FROM THE REVISED ORDINANCES OF THE CITY OF AUBURN.

"Be it ordained by the Mayor, Aldermen and Common Council of the City of Auburn, as follows: That chapter eight of the revised ordinances be amended by adding thereto the following section, viz.:

"Section 14. Whenever there is an adequate public sewer or drain built or maintained by the City of Auburn in any of the streets, alleys or lanes thereof, if the Board of Health or a majority thereof shall be of opinion and shall so adjudge that the waste water, slops and human excreta upon, and incident to

the use of, any building or buildings or premises, on lots contiguous to any of said streets, alleys or lanes in which is any such sewer or drain, but not connected with such sewer or drain through proper and authorized plumbing, are offensive to sight or smell, or are dangerous to life or health, the owner or owners of such house or premises shall forthwith connect said house or premises with said sewer, and shall thereafter drain all wash water, waste water, slops and human excreta from said building or premises into said sewer. And any such owner or owners, who after thirty days' notice in writing from the Board of Health that said waste water, slops and human excreta are offensive to sight or smell, or are dangerous to life or health, and that he or they must forthwith connect said house or premises with said sewer or drain, shall fail or neglect to make such connection in a manner satisfactory to the Board of Health; or if such connection has been made, shall thereafter fail or neglect after such notice to cause all wash water, waste water, slops and human excreta to be drained from said building or premises into and through said sewer, shall forfeit and pay for each week's failure or neglect, not exceeding twenty dollars to be recovered in an action of debt for the use of the city.

Auburn, September 17, 1890.

Approved:

Enoch Foster, Justice of the Supreme Judicial Court.

AUGUSTA. 1897. There were reported to me during the year two cases of diphtheria, two of scarlet fever, and thirty-six of typhoid fever. I have noticed that the great majority of our typhoid fever cases occur during the months of January, February, and March. I have been very careful during the past year to instruct the physicians in attendance to use the utmost precaution in the disinfecting of excreta and in adopting every other precaution possible to prevent the occurrence of new cases. A formaldehyde generator was obtained in June, and it has been used in all cases of contagious diseases that have occurred since that time.

It is the intention of the board to continue the services of our efficient sanitary inspector, Mr. E. R. Bean, having a house to house inspection made during the warm months. It is also the intention of the board to have pure spring water placed in the

schoolhouses during the coming year.—Dr. W. H. Harris, H. O.

AURORA. No infectious diseases have been reported.—A. E. Mace, Sec.

AVON. No cases of infectious diseases in 1896, but in 1897 one case of diphtheria. One nuisance removed.—G. T. Jacobs, Sec.

BAILEYVILLE. No cases of infectious disease in either year. —J. D. Lawler, Sec.

BALDWIN. 1896. Two cases of typhoid. 1897. One case of scarlet fever and two cases of measles.—A. Spencer, Sec.

BANCROFT. 1897. We had no cases of infectious disease.— T. B. Fitzpatrick, Sec.

BANGOR. 1896. About one hundred thirty nuisances, all of which were abated. We have laid 4,626 feet of new sewers. A new filter has been put in at our pumping station. We have been making an improvement in our water supply. There were seven cases of diphtheria, twenty-seven of scarlet fever, and fifty of typhoid fever. Houses in which cases of consumption occur are supplied with Circular No. 54 through the hands of the attending physician.

1897. About one hundred nuisances have been removed or discontinued. This year 3,400 feet of sewers have been built. We have had five cases of diphtheria, twenty of scarlet fever, and about fifty of typhoid fever. In the work of disinfection a formaldehyde generator is used.—John Goldthwait, Sec.

BARING. 1896. Three cases of typhoid fever. 1897. No infectious diseases.—G. F. Winslow, Sec.

BARNARD PLANTATION. 1897. No infectious diseases.—W. E. Austin, Sec.

BATH. 1896. It is pleasing to observe a wholesome change in sentiment among most of our citizens and to see a better disposition on the part of most of the recent city governments towards appropriations for drains and sewers, things so nearly allied to public and private health. Until the city is better drained than it is to-day, no money should be more generously appropriated than that which goes into better drainage, appealing at once to the good health and consequent earning and producing capacity of our citizens. With a city of 9,000 inhabitants, whose death-rate has been above the normal for twenty-

five consecutive years, enjoying an appropriation of $800 per year for drains and sewers, and liberal appropriations for less important matters, makes one interested in the good health of individuals, and sanitation, feel as though municipalities sometimes place small value on the lives and health of individuals, and yet, good sanitation saves many lives to the State every year. When the estimated earning capacity of a healthy man is $1,000 per year, any policy which thwarts the protection of individuals or municipalities in good sanitation, only depletes its own quota of possible inhabitants and consequent earning individuals, and deprives the State and city of a commercial and productive source, even if there was no more humane or elevating side to the question.—Dr. E. M. Fuller, Sec.

1897. We have had fifteen cases of scarlet fever and five of typhoid fever. Measles was prevalent in the latter part of the year.—C. F. Rideout, Sec.

BEDDINGTON. No infectious diseases reported.—A. F. Libbey, Sec.

BELFAST. 1896. Seventy-five nuisances reported to the board, all of which were removed, except about fifteen. We had two cases of diphtheria and seven mild cases of typhoid fever. Whooping cough was prevalent in the latter part of the year.—Dr. L. W. Hammons, Sec.

1897. Eleven nuisances were removed. Four cases of diphtheria and one of typhoid fever. When our sewerage system is completed we shall have all we can ask for.—Dr. S. W. Johnson, Sec.

BELGRADE. 1896. One case of typhoid fever. Whooping cough was prevalent.

1897. Four cases of typhoid fever.—Dr. L. E. Reynolds, Sec.

BELMONT. 1896. Nothing but whooping cough.

1897. Three cases of typhoid fever, and whooping cough in January.—C. R. Andrews, Sec.

BENEDICTA. No cases of infectious disease present.—P. R. Owen, Sec.

BENTON. 1896. One case of diphtheria and six of typhoid fever.

1897. Seven cases of diphtheria. Measles was present in the spring. One nuisance removed each year.—A. L. Plummer, Sec.

BERWICK. 1896. Nine nuisances, of which eight were removed. Four cases of typhoid fever. One case of measles.

1897. Eight nuisances removed. One case each of scarlet fever and typhoid fever.—Dr. A. C. Ferguson, Sec.

BETHEL. 1896. Two nuisances removed. Nine cases of diphtheria and three of typhoid fever.

1897. All complaints of nuisances attended to. Four cases of diphtheria and one of typhoid fever. Measles has been present.—A. W. Grover, Sec.

BIDDEFORD. 1896. Two hundred seventy-five nuisances, of which 243 were removed. The Biddeford and Saco Water Company have put in a new, modern filtering plant. We had twelve cases of diphtheria, four of scarlet fever, and sixty of typhoid fever. Cases of membranous croup have been quarantined as in diphtheria. The work of our board would be vastly more efficient if we had improved methods of removing garbage and night soil, both of which we hope to secure during the coming year.

1897. Over one hundred nuisances were removed. One case of diphtheria, two of scarlet fever, and twenty-four of typhoid fever. Measles was prevalent in a parochial school.—Dr. F. L. Davis, Sec.

BINGHAM. 1896. Two cases of scarlet fever and one of typhoid fever. Schools were stopped on account of the prevalence of whooping cough.

1897. Two nuisances removed. No cases of contagious disease this year.—T. F. Houghton, Sec.

BLAINE. 1896. Six cases of scarlet fever and several cases which the attending physician called membranous croup. The board has had the premises in this village and in Robinson village put in a better sanitary condition than they ever were before.—G. W. Young, Sec.

1897. We had no contagious diseases.—Dr. A. J. Fulton, H. O.

BLANCHARD. There was an absence of contagious disease during both years.—E. P. Blanchard, Sec.

BLUEHILL. 1896. Three cases of scarlet fever and six of typhoid fever.

1897. Twelve cases of typhoid fever, but none of diphtheria or scarlet fever. Measles was prevalent in the spring months.

and whooping cough in the summer and autumn. Better ventilation in school-houses and in public buildings is needed.—Dr. R. P. Grindle, Sec.

BOOTHBAY. 1896. One nuisance removed. Three cases of typhoid fever; none of the other diseases.—Dr. Alden Blossom, Sec.

BOOTHBAY HARBOR. 1896. Three nuisances removed. Three cases of typhoid fever. Otherwise no outbreaks of infectious diseases.—Dr. Alden Blossom, Sec.

1897. One nuisance removed. One case of typhoid fever. Whooping cough was present in the summer months. It has been a very healthful year.—Dr. G. A. Gregory, Sec.

BOWDOIN. 1896. Three cases each of scarlet fever and typhoid fever.

1897. We had twelve cases of diphtheria and eight of scarlet fever. The first case of diphtheria was not reported by the physician as the law requires. The doctor said it was tonsilitis and contagious. Mr. Chase visited the family and found one boy dead and four other children sick with the same disease. The family was quarantined at once and three others that had been exposed.—A. P. Small, Sec.

BOWDOINHAM. 1896. Six cases of typhoid fever.

1897. Eight cases of typhoid fever, but none of the other diseases. Measles has been treated as scarlet fever and diphtheria. Our public health work would be rendered more efficient by educating the people in regard to these matters, and this is gradually being done.—Dr. I. C. Irish, Sec.

BOWERBANK PLANTATION. 1896. No infectious diseases.—E. J. Donald, Sec.

1897. We had nine cases of measles, but none of the other infectious diseases.—Edward Clark, Sec.

BRADFORD. One nuisance removed. No cases of infectious diseases, except one of scarlet fever in 1896, and some prevalence of whooping cough.—L. W. Coy, Sec.

BRADLEY. 1897. Two nuisances removed. Three cases of typhoid fever, but none of the other diseases.—H. H. Bullen, Sec.

BREMEN. We have had none of the infectious diseases, with the exception of one case of typhoid fever in 1897.—W. B. Hilton, Sec.

BREWER. Four or five hundred feet of sewers have been built. All nuisances reported have been removed as far as possible. We had fifteen cases of typhoid fever, but none of diphtheria or scarlet fever.—W. H. Gardiner, Sec.

BRIDGEWATER. 1896. Four cases of diphtheria.—E. C. Folsom, Sec.

1897. No infectious diseases, except whooping cough in December.—Henry Bradstreet, Sec.

BRIDGTON. 1896. One case eachof scarlet fever and typhoid fever.

1897. Three cases of typhoid fever. When nuisances have been found the people have been ready and willing to make improvements when called upon.—I. S. Webb, Sec.

BRIGHTON PLANTATION. We have had no infectious diseases, with the exception of one case of typhoid fever in 1896. J. C. Adams, Sec.

BRISTOL. 1896. Two nuisances removed. One case of typhoid fever.

1897. Two nuisances removed. No infectious diseases, save two cases of typhoid fever.—Geo. E. Little, Sec.

BROOKLIN. 1896. One nuisance removed. Eight cases of scarlet fever. Prompt precautions were taken to prevent the spread of the disease. Whooping cough in a mild form.

1897. We have had no infectious diseases, save three mild cases of scarlet fever. In connection with cases of consumption, we have tried to educate the people in regard to the need of the disinfection of sputum, by giving them copies of the circulars relating to consumption. I think it has done much good. As to methods of rendering our work more efficient, I would suggest the distribution of your reports and the general circulation of *The Sanitary Inspector*. I wish every family were subscribers and readers of this excellent journal.—E. P. Cole, Sec.

BROOKSVILLE. 1896. One case of diphtheria and two of typhoid fever.—O. L. Tapley, Sec.

1897. We have had no cases of infectious diseases, with the exception of whooping cough which caused the closure of one school. An unusually healthful season.—Dr. L. A. Stewart, Sec.

BROOKTON. 1897. Two cases of typhoid fever; none of diphtheria or scarlet fever.—A. O. Fish, Sec.

BROWNFIELD. There were no cases of diphtheria, scarlet fever, or typhoid fever during the two years.—H. F. Fitch, Sec.

BROWNVILLE. 1896. We had two cases of typhoid fever and one case of membranous croup.

1897. Fifteen nuisances, all of which were removed. Three cases of typhoid fever.—T. W. Pratt, Sec.

BRUNSWICK. 1896. All nuisances reported were removed. We had two cases of typhoid fever and some cases of diphtheria and scarlet fever, the number of which I am unable to give on account of the death of the former secretary.—W. O. Peterson, Sec.

1897. Twenty nuisances reported, of which seventeen were adjudged nuisances and abated. There were four cases of diphtheria, three of scarlet fever, and six of typhoid fever. It has been a quiet year from a physician's point of view. In our disinfecting work we are using a formaldehyde generator.—Dr. G. M. Elliott, Sec.

BUCKFIELD. 1897. One case each of scarlet fever and typhoid fever. Prompt measures were taken to prevent their spread. Two cases of membranous croup were treated as diphtheria.—H. D. Irish, Sec.

BUCKSPORT. 1896. Two nuisances removed. No infectious diseases reported, save one case of typhoid fever.—P. P. Gilmore, Sec.

BURLINGTON. 1896. No infectious diseases.

1897. Five cases of scarlet fever and one of typhoid, which were looked after carefully. We had a meeting of the board April 3, at which it was voted to meet once a month during the hot weather and to make a monthly inspection.—Thomas Shorey, Sec.

BURNHAM. One nuisance removed. There were no cases of diphtheria, scarlet fever, or typhoid during the two years. One case of measles in 1897.—N. E. Murray, Sec.

BUXTON. 1896. Nine nuisances, eight of which were abated. One case of diphtheria and three of scarlet fever. In cases of pulmonary tuberculosis, the expectoration is looked after and disinfected either by burning on cloth or paper or with a powerful germicide.

1897. Seven nuisances removed. Two cases of diphtheria and three cases of measles.—Dr. A. H. Weeks, Sec.

BYRON. One nuisance abated. No infectious diseases, except one case of typhoid in 1897, and measles and whooping cough in the same year.—H. H. Richards, Sec.

CALAIS. 1896. Twenty-four nuisances removed. We have had fifteen cases of diphtheria, forty-one of scarlet fever, and thirty-five of typhoid. Our greatest need is a system of sewers throughout the city.

1897. Ten nuisances removed. Three cases of diphtheria, one of scarlet fever, and two of typhoid. Cases of membranous croup are treated as diphtheria.—Dr. J. R. N. Smith, Sec.

CAMBRIDGE. 1897. We have had no cases of infectious diseases during the year, excepting a few of whooping cough before the board was organized.—Samuel Sawyer, Sec.

CAMDEN. 1896. Fourteen nuisances, nearly all of which were removed. We have had two cases of diphtheria, three of scarlet fever, and two of typhoid fever. Our schools are all right, new floors, steam heating, and sewers. Each room is thoroughly cleaned three times a year.

1897. Nine nuisances, all of which were removed. Two cases of membranous croup and sixty-four of scarlet fever.—A. Buchanan, Sec.

CANAAN. Two nuisances removed. One case of typhoid fever in 1896, but no cases of diphtheria or scarlet fever.—Dr. L. W. Shean, Sec.

CANTON. 1896. Two nuisances removed. Two cases of scarlet fever and one of typhoid fever. The two cases of scarlet fever we believe came from the same house in a neighboring town; the first case early in the spring and the second case in the fall. No spread from either case.

1897. Several nuisances removed. One case of scarlet fever; none of diphtheria or typhoid fever.—R. A. Barrows, Sec.

CAPE ELIZABETH. 1897. One nuisance removed. One case of diphtheria, four of scarlet fever, and one of typhoid. Measles in January and February.—E. F. Hill, Sec.

CARATUNK PLANTATION. 1896. No infectious diseases.—N. P. Brown, Sec.

1897. One case of typhoid fever and some cases of measles. —W. D. Moore, Sec.

CARIBOU. 1896. Eight nuisances, seven of which were discontinued. Nine cases of scarlet fever and fourteen of typhoid.

1897. Five nuisances removed. Six cases of scarlet fever and one of typhoid. No cases of diphtheria. Cases of membranous croup, when present, are treated much the same as if it were diphtheria.—Dr. J. Cary, Sec.

CARMEL. 1896. One nuisance removed. One case of typhoid, but none of diphtheria or scarlet fever.

1897. Three cases of typhoid.—F. A. Simpson, Sec.

CARROLL. 1896. One nuisance removed. One case of scarlet fever.

1897. Four cases of diphtheria and one of membranous croup. I think that a stop should be put to the practice of distributing text-books in the schools first from one scholar to another. I think that disease is sometimes conveyed in that way.—Hiram Stevens, Sec.

CARTHAGE. 1897. No cases of diphtheria, scarlet fever, or typhoid fever, but whooping cough was prevalent in August and September.—C. F. Eaton, Sec.

CARY PLANTATION. 1897. No outbreaks of infectious disease.—L. P. Libby, Sec.

CASCO. 1896. One case of diphtheria and two of scarlet fever.

1897. One nuisance removed. No infectious outbreak, save one case of typhoid fever.—Dr. Walter Corliss, Sec.

CASTINE. 1896. Water has been put into a part of the town and the plant is being extended. No infectious diseases. We need a more complete system of sewerage.

1897. Measles was prevalent in November and December, but we had no cases of diphtheria, scarlet fever, or typhoid. Four nuisances removed each year.—Dr. S. J. Wallace, Sec.

CASTLE HILL PLANTATION. 1896. One case of typhoid.—D. A. Jackson, Sec.

1897. Five cases of diphtheria and seven of scarlet fever. In these cases, all the inmates of the infected houses were forbidden to leave the premises and were ordered to allow no outsider to enter. In regard to what way the public health work of our board could be rendered more efficient, I would say that I think all the health officers should have power to take into custody all persons who defy their orders. There is a certain

class of people who will go as they please and do as they please in spite of the orders of the local board of health.—Geo. S. Young, Sec.

CASWELL PLANTATION. 1896. One case of diphtheria. The house was quarantined and thoroughly disinfected.—L. F. Patten, Sec.

CHAPMAN PLANTATION. 1896. No infectious diseases.—E. C. Cook, Sec.

CHARLESTON. 1896. Sixteen cases of scarlet fever, and whooping cough was quite prevalent the first of the year.

1897. One nuisance removed. One case of typhoid fever. Our work would be rendered more efficient by the hearty coöperation of the public.—Dr. G. B. Noyes, Sec.

CHARLOTTE. No infectious diseases, excepting a few cases of mumps.—D. P. Fisher, Sec.

CHELSEA. No cases of diphtheria, scarlet fever, or typhoid.

1897. One case each of scarlet fever and typhoid.—W. T. Searls, Sec.

CHERRYFIELD. 1896. Three cases of typhoid fever, but none of diphtheria or scarlet fever. There were five cases of acute anterior poliomyelitis of children in the month of August.

1897. One case of typhoid fever. But little sickness during the year.—Dr. C. J. Milliken, Sec.

CHESTER. 1896. No infectious outbreaks reported.

1897. Twenty-three cases of scarlet fever and nine of measles. These occurred in the early part of the year.—J. D. Kyle, Sec.

CHESTERVILLE. 1896. No infectious diseases.

1897. One case of diphtheria and one of typhoid. One nuisance each year abated.—S. T. Grant, Sec.

CHINA. 1896. Two nuisances removed. One case of typhoid, but none of the other diseases except an outbreak of measles.

1897. One nuisance removed. Two cases of typhoid fever. Cholera infantum was remarkably prevalent in the autumn.—Dr. G. J. Nelson, Sec.

CLIFTON. No infectious diseases in either year.—Wm. H. Parks, Sec.

CLINTON. 1896. Four cases of diphtheria and six of typhoid.

1897. One case of diphtheria, seven of scarlet fever, and three of typhoid. As the people become more interested in public health work they see the need of it and show a greater willingness to help the board carry it out. Four nuisances in each year, all of which were removed.—Dr. A. Shaw, Sec.

CODYVILLE PLANTATION. One nuisance removed. No outbreaks of infectious diseases.—T. O. Hill, Sec.

COLUMBIA. 1896. One nuisance removed. Fifteen cases of scarlet fever were looked after in accordance with the requirements of the law.—C. L. Coffin, Sec.

1897. We have had no infectious diseases.—J. E. Stewart, Sec.

COLUMBIA FALLS. 1896. Two nuisances removed. No infectious diseases reported.

1897. One case of scarlet fever and one of typhoid. We had one outbreak of measles.—E. A. White, Sec.

CONCORD. 1896. No infectious diseases.—E. O. Vittum, Sec.

1897. Five nuisances removed. No outbreaks of infectious diseases.—O. Thompson, Sec.

COOPER. 1896. One case of typhoid fever.

1897. No infectious diseases reported.—W. G. Day, Sec.

COPLIN PLANTATION. Diphtheria, scarlet fever, and typhoid fever were absent both years.—F. T. Blackwell, Sec.

CORINNA. 1896. One case of typhoid and several cases of whooping cough.—F. L. Redman, Sec.

1897. Two nuisances removed. Two cases of typhoid.—J. C. Pease, Sec.

CORINTH. 1896. We have been wonderfully blessed during the past year by having no epidemics and in escaping disease generally. The epidemic of scarlet fever in Charleston came quite near the town line, but thanks to the timely assistance of the State board it was checked before reaching Corinth. —Dr. H. D. Worth, Sec.

1897. With the exception of one case of measles, we have had no infectious diseases.—Dr. C. S. Philbrick, Sec.

CORNISH. 1896. One case of typhoid fever.

1897. One case of scarlet fever and two of typhoid. In the one case of scarlet fever which occurred in one of our schools,

the school was promptly closed and disinfected together with all the books, formic aldehyde gas and sulphur being used.—Geo. H. Parker, Sec.

CORNVILLE. No outbreaks of infectious diseases in the two years. We have had just about nothing to do, but have been ready for work if it came.—S. S. Woodman, Sec.

CRANBERRY ISLES. 1896. No infectious diseases, except measles in May.—W. P. Preble, Sec.

1897. Two nuisances removed. No infectious diseases.—G. W. Bulger, Sec.

CRAWFORD. No infectious diseases in the two years. Our town has been very healthful. Three nuisances, two of which were removed.—J. P. Jeffery, Sec.

CRIEHAVEN PLANTATION. 1897. We have had no cases of diphtheria, scarlet fever, or typhoid. We are all hard working fishermen, but will do our best to keep the places clean and the water pure.—E. W. Crie, Sec.

CRYSTAL PLANTATION. 1897. No outbreaks of infectious diseases.—A. A. Emerson, Sec.

CUMBERLAND. 1896. Three cases of diphtheria, two of scarlet fever, and two of typhoid. There was also some prevalence of measles.

1897. Three nuisances, all of which were removed. We have had no infectious diseases, with the exception of measles and whooping cough.—Dr. H. M. Moulton, Sec.

CUSHING. 1896. Seven cases of scarlet fever and there was some prevalence of measles and whooping cough.

1897. Five cases of diphtheria.—W. A. Rivers, Sec.

CUTLER. 1896. Two nuisances, both of which were removed. With the exception of whooping cough in June and July, we have had no infectious diseases.—Geo. Gardiner, Sec.

1897. No infectious diseases.—L. Davis, Sec.

CYR PLANTATION. No cases of diphtheria, scarlet fever, or typhoid, but whooping cough in the fall of 1896.—Edward Cyr, Sec.

DALLAS PLANTATION. In 1896, there were seven cases of diphtheria, and in 1897, forty-seven, although all possible ways to prevent the spread of the disease were taken.—Ella G. Adams, Sec.

DAMARISCOTTA. 1896. We now have public water works in running order with fine water and good pressure. Two nuisances removed. Six cases of scarlet fever, but none of diphtheria or typhoid. Two or three cases of measles. The failure of physicians to report their cases promptly is one of the worst things the local board has to contend with. Some report promptly and some do not.

1897. About one-half dozen nuisances were reported, some of which we were unable to abate. Seven cases of scarlet fever. This is the pest of this town and vicinity. Of each outbreak the source has been a mystery, but I have a suspicion that the germs are lurking in unused part of houses, in cast-off clothing, for instance. Our experience has suggested that towns ought to be required to furnish disinfectants to householders of infected houses. It is the logical thing for such householders to expect, and they still continue to presume that the town is furnishing the disinfectants until the bill is presented.

We still think that five cents per capita appropriation should be made each year by the town, or some definite amount for the use of the local board, and that the town be compelled by statute to do so.—A. H. Snow, Sec.

DANFORTH. 1896. Nine nuisances, eight of which were abated. Two cases of typhoid fever. Better drainage is needed.

1897. Seven nuisances removed. Measles was present in April and May, but no cases of diphtheria, scarlet fever, or typhoid.—Dr. M. L. Porter, Sec.

DAYTON. 1896. One case of typhoid fever.

1897. One case of typhoid. There has been nearly a total exemption from contagious and infectious diseases. We think all cases of severe tonsilitis, or sore throat should be quarantined at once, for there are cases of diphtheria which it is impossible to diagnose in the earlier stages. We have also seen cases of well developed scarlatina in neighboring towns the past year which originated from persons sick with so-called tonsilitis. If physicians and boards of health would look carefully after cases of tonsilitis, they would often prevent the spread of diphtheria and scarlet fever.—Dr. Geo. Sylvester, Sec.

DEAD RIVER PLANTATION. During the two years we had no infectious diseases, except one case of typhoid fever in 1897.

Our climate is remarkably healthful; the breezes from old Mount Bigelow are rejuvenating, and we hope to die of old age.—S. A. Parsons, Sec.

DEBLOIS. 1897. No infectious diseases.—A. H. Nelson, Sec.

DEDHAM. No outbreaks of infectious diseases in either year. —W. W. Burrill, Sec.

DEERING. 1896. Thirty-five nuisances, all of which were removed. Three cases of diphtheria, eleven of scarlet fever, and five of typhoid. There were some cases of measles. We need a further extension of our sewerage system.

1897. Thirty-three nuisances reported, all of which were abated. Diphtheria, eighteen; scarlet fever, sixteen; and typhoid, nine cases. Some prevalence of measles. Much effort has been expended to induce the parties to enter the sewers, of which we have a good system, and many have done so. We think we are doing very good work and that the people are in sympathy with it.—Dr. R. F. Goodhue, Sec.

DEER ISLE. 1896. Two nuisances were abated. Four cases of scarlet fever and four of typhoid.—A. J. Beck, Sec.

1897. One nuisance removed. Two cases of scarlet fever and one of typhoid.—G. W. Small, Sec.

DENMARK. In 1896, four nuisances were removed simply by bringing the fact of their existence to the attention of those responsible for them, and in 1897, one nuisance was removed. In neither year were there any outbreaks of infectious diseases. There was one case of cerebro-spinal meningitis in 1897 in a family of five children. The other children were away from home as much as possible; the most of them being sent away from the house and kept away until after the house was cleansed. —Dr. S. T. Brown, Sec.

DENNISTOWN PLANTATION. We had no infectious diseases, except one case of typhoid fever in 1896, and measles and whooping cough from July to September of 1897.—W. J. Henderson, Sec.

DENNYSVILLE. One nuisance removed. No epidemic outbreaks in either year. There were a great many cases of jaundice in this and neighboring towns through the fall and early winter.—F. L. Gardner, Sec.

DETROIT. No contagious diseases in either year.—D. F. Libbey, Sec.

DEXTER. Three cases of typhoid fever in 1896 and four in 1897, but none of diphtheria or scarlet fever. Whooping cough was prevalent in July and August of the former year. Five nuisances removed in each year.—E. A. Russ, Sec.

DIXFIELD. One nuisance removed. No cases of diphtheria, scarlet fever, or typhoid, but whooping cough was prevalent in June and July, 1897, and there were three cases of measles. A young lady came home from school on a vacation in March; "she went to a party one evening suffering with a cold and cough." The next morning the secretary of the local board was called and found a fully developed case of measles. On inquiry, it was found that about ten young people were in the same room who had never had the disease. The young lady's sister and one other young lady, however, were the only ones who took the disease from her.—Dr. J. S. Sturtevant, Sec.

DIXMONT. 1896. No especially prevalent diseases and no contagious ones.

1897. Ten cases of scarlet fever.—B. D. Prilay, Sec.

DOVER. 1896. Two nuisances, both of which were removed. One case of diphtheria, two of scarlet fever, and two of typhoid. We very much need improved sewerage.

1897. Four nuisances removed. Six cases of scarlet fever, two of typhoid, and some prevalence of measles.—G. G. Downing, Sec.

DRESDEN. 1896. Five cases of scarlet fever, but none of diphtheria, or typhoid. The health of the people in this section is most excellent.

1897. No contagious diseases, save two cases of scarlet fever.—Dr. L. H. Dorr, Sec.

DREW PLANTATION. No contagious diseases, save one case of typhoid fever in 1896.—F. I. Grant, Sec.

DURHAM. 1897. No infectious diseases.—Dr. J. L. Wright, Sec.

DYER BROOK. One nuisance removed. No cases of contagious diseases in the two years. The health of many homes would be improved by cleaning up the cellars in the spring instead of in June or July.—A. F. Lougee, Sec.

EAGLE LAKE PLANTATION. 1895. No contagious diseases. 1897. Four cases of typhoid.—J. M. Brown, Sec.

EASTBROOK. No outbreaks of contagious diseases.—Alden Dyer, Sec.

EAST LIVERMORE. 1896. Eight nuisances, all of which were removed. Three cases of scarlet fever. A system of public water works is needed.—S. A. Nelke, Sec.

1897. One nuisance removed. One case of diphtheria and six of typhoid. Whooping cough was prevalent. The health work of the board would be rendered more efficient if we had good sewerage, a good water supply, and a better educated public opinion on matters pertaining to public health.—Dr. C. H. Gibbs, Sec.

EAST MACHIAS. 1896. Four cases of diphtheria.—A. J. Hanscom, Chr.

EASTPORT. 1896. The city has completed over 3,000 feet of sewerage in a section where it was much needed. Eight cases of diphtheria and twelve of typhoid fever. Cases of membranous croup are treated the same as diphtheria.

1897. Fifty nuisances, all attended to. Diphtheria, five, and typhoid fever, three cases.—H. H. Wadsworth, Sec.

EDDINGTON. One nuisance removed. No infectious diseases.—G. W. Estes, Sec.

EDEN. 1897. Many improvements have been made in water and sewerage. The dump is now taken away to sea by scows made for that purpose. Many nuisances have come to the attention of the board and all have been promptly removed. One case of diphtheria and two of scarlet fever. One member of our board acts as health officer all the time, and he works with the Village Improvement Society which spends thousands of dollars yearly on improvements, cleaning up decaying matter, cleaning the streets every Monday, and many other improvements.—C. E. Conners, Sec.

EDGECOMB. 1896. Two nuisances, both removed. No infectious diseases, except whooping cough.

1897. One nuisance removed. One case of typhoid fever and quite a prevalence of whooping cough. We have had an unusually small number of deaths in town this year. One case supposed to be tuberculosis in a cow was reported to the State

Veterinarian, but he could not come. The cow died and was buried, and the necessary precautions were taken.—Eben Chase, Sec.

EDINGBURG. No infectious diseases.—C. W. Eldredge, Sec.

EDMUNDS. 1896. One case of diphtheria.—C. W. Hobart, Sec.

1897. No infectious diseases. Our town is very healthful and more so this year than usual.—C. E. Hayward, Sec.

ELIOT. 1896. Three cases of typhoid fever. Tonsilitis in November and December.

1897. One nuisance removed. Two cases each of scarlet fever and typhoid. We have found nearly always our cases of typhoid due to the condition of the drinking water. By boiling the water used by the inmates of a house and attending carefully to the disposal of excreta, we have no trouble in controlling typhoid fever.—Dr. H. I. Durgin, Sec.

ELLIOTTSVILLE PLANTATION. No infectious diseases in the two years.—H. W. Lane, Sec.

ELLSWORTH. 1896. Improvements have been made in water supply and drainage. Twenty-two nuisances, all of which were removed, so far as practicable. Sixteen cases of typhoid fever. The construction of a suitable sewerage system is very much needed. A more prompt and careful report of infectious diseases by physicians would be appreciated.—G. A. Parcher, Sec.

1897. Twenty-five nuisances, all but two of which were removed. One case of scarlet fever and six of typhoid. There was an outbreak of measles in the early spring. Disinfection with formaldehyde has been introduced. The health of the children in our primary schools would be improved if they were not allowed to carry so much mud and filth into the schoolroom on their feet. It is shuffled about, quantities of dust arise, they inhale it, and it lays the sure foundation for bronchitis and kindred troubles. In this past year, there were eleven deaths from bronchitis.—M. S. Smith, Sec.

ENFIELD. 1896. One nuisance was removed. One case of scarlet fever.

1897. Three nuisances, all of which were removed. No infectious diseases.—A. J. Darling, Sec.

ETNA. 1896. Two cases of typhoid fever. Whooping cough was prevalent. The health of our town is very good. Our cases of typhoid fever were brought from outside.

1897. Two cases of diphtheria. One case of measles appeared in a person who was isolated and no other cases appeared. Some cases of tonsilitis.—S. J. Locke, Sec.

EUSTIS. 1896. Four cases of typhoid fever.

1897. Two cases of typhoid fever. Measles in July.—Dr. T. W. Brimigion, Sec.

EXETER. 1897. Two cases of typhoid fever.—E. J. Ames, Sec.

FAIRFIELD. 1896. Ten nuisances, all but one of which were removed. Two cases of diphtheria and three of typhoid fever.

1897. Twenty-eight nuisances, all of which so far as possible were abated. Six cases of diphtheria, nine of scarlet fever, and three of typhoid. What we need more than anything else is a system of sewerage.—Geo. C. Eaton, Sec.

FALMOUTH. 1896. One case of typhoid fever.

1897. One nuisance removed. Six cases of diphtheria and one of scarlet fever. Measles in the fall.—H. J. Merrill, Sec.

FARMINGDALE. 1896. One nuisance abated. One case of diphtheria. This town has been quite healthful.

1897. Two cases of scarlet fever.—J. H. Burnham, Sec.

FARMINGTON. 1896. Twelve nuisances; all were abated except one which could not be removed for the want of a sewer. Scarlet fever, two cases; typhoid fever, five. A system of sewerage is needed more than anything else.

1897. Seven nuisances, all of which were removed. Three cases each of diphtheria and typhoid. Whooping cough was prevalent.—Dr. F. O. Lyford, Sec.

FAYETTE. No infectious diseases, except two of typhoid fever in 1896, and whooping cough this last year.—H. J. Tuck, Sec.

FLAGSTAFF PLANTATION. 1896. No infectious diseases.—J. R. Viles, Sec.

FOREST CITY. 1896. One nuisance removed. No infectious diseases.

1897. One case of typhoid fever.—Dr. W. A. Van Wartt, H. O.

FORT FAIRFIELD. 1896. All nuisances were removed. One case of diphtheria, two of scarlet fever, and three of typhoid.—N. H. Martin, Sec.

1897. Three cases of scarlet fever.—Dr. R. H. Perkins, Sec.

FORT KENT. 1896. Seven cases of typhoid fever.

1897. Five nuisances, all removed. No cases of scarlet fever or typhoid fever, but in our outbreak of diphtheria we had one hundred seventy-six cases in thirty-eight houses.—Dr. F. G. Sirois, H. O.

FRANKFORT. 1896. No infectious diseases.—F. L. Hopkins, Sec.

1897. Two nuisances, one of which was removed. Three cases of typhoid. The sanitary condition of the town would be improved by better drainage and more attention to the condition of privies and sink spouts.—Dr. O. S. Erskine, Sec.

FRANKLIN. 1896. Two cases of typhoid fever. Whooping cough in March and April.

1897. Two nuisances, one of which was abated. Whooping cough in the spring.—G. U. Dyer, Sec.

FRANKLIN PLANTATION. 1896. One case of scarlet fever.

1897. One nuisance removed, but no infectious diseases.—L. C. Putnam, Sec.

FREEDOM. One nuisance removed. No infectious diseases in the two years, except whooping cough in the fall of 1896.—Dr. A. M. Small, Sec.

FREEMAN. 1896. No infectious diseases.

1897. One nuisance removed. One case of diphtheria and a number of cases of measles in the fall.—N. H. Peterson, Sec.

FREEPORT. 1896. Eight nuisances, all removed. One case of typhoid fever and one case of membranous croup.

1897. Two nuisances removed. One case of typhoid fever. Measles was prevalent in the spring. For special work we have had some old cesspools cleaned and put in good shape, drainage improved, rubbish removed, and signs put up. Our town needs a sewerage system.—Dr. J. E. Gray, Sec.

FRENCHVILLE. 1896. No infectious diseases reported.—Dr. I. Coté, Sec.

FRIENDSHIP. 1896. Two nuisances removed. Three cases of diphtheria.

1897. No infectious diseases. Mumps in November.—F. G. Jameson, Sec.

FRYEBURG. 1896. One nuisance removed. Four cases of typhoid fever.

1897. Two nuisances removed. No infectious diseases.—Dr. W. C. Towle, Sec.

GARDINER. 1896. About 2,500 feet of sewer pipe was laid. Ten nuisances, of which six were abated. Twenty-two cases of diphtheria, two of scarlet fever, six of typhoid fever, and five of measles. Infectious houses are quarantined and a man provided to attend to the wants of the inmates. Steam disinfection of clothing. Floors, walls, and furniture washed in bichloride solution. Only one second case has occurred in the same house after disinfection.

1897. Ten nuisances, eight of which were removed. Seven cases of diphtheria, forty-seven of scarlet fever, and six of typhoid.—Dr. F. E. Strout, Sec.

GARFIELD PLANTATION. No infectious diseases. When contagious diseases do arise we are on the alert to stop them at once.—Angus Young, Sec.

GARLAND. 1896. One case each of diphtheria, scarlet fever, and typhoid fever.

1897. Two nuisances removed. Seven cases of diphtheria, one of scarlet fever, and one of typhoid. Whooping cough was prevalent in September, and infectious jaundice in December. Membranous croup is treated the same as diphtheria.—Dr. F. A. Emerson, Sec.

GEORGETOWN. No infectious diseases.—S. P. Oliver, Sec.

GILEAD. One case of typhoid fever in each of the two years. One nuisance removed.—J. K. Heath, Sec.

GLENBURN. 1896. No infectious diseases save whooping cough in one school district. The condition of the public health would be improved if one-half of the old schoolhouses could be disposed of or burned down, or new ones built in their places with better ventilation, better lighting, and better sanitary surroundings.

1897. No infectious diseases.—John F. Tolman, Sec.

GLENWOOD PLANTATION. No infectious diseases.—Wm. H. Grant, Sec.

GORHAM. 1896. The Sebago water has been put into the village. All nuisances, six in number, have been removed. Two cases of diphtheria, three of scarlet fever, and two of typhoid.

1897. No cases of diphtheria, scarlet fever, or typhoid, but we had twelve cases of measles.—Geo. W. Heath, Sec.

GOULDSBORO. 1896. Three cases of diphtheria.—O. K. Stevens, Sec.

1897. No infectious diseases.—S. L. Tracy, Sec.

GRAFTON. No infectious diseases in either year.—J. W. Chapman, Sec.

GRAND ISLE. 1896. One case of diphtheria.

1897. No cases of diphtheria, scarlet fever, or typhoid have appeared in this town.—F. Sanfacon, Sec.

GRAND FALLS PLANTATION. 1897. No infectious diseases. —J. A. Littlefield, Sec.

GRAND LAKE STREAM PLANTATION. 1897. One case of diphtheria. Measles and whooping cough in the fall.—W. B. Hoar, Sec.

GRAY. 1896. Two nuisances, both of which were removed. One case each of diphtheria and typhoid.

1897. Two cases of scarlet fever.—G. W. Osgood, Sec.

GREENBUSH. No infectious diseases.—H. F. Harris, Sec.

GREENE. 1896. One nuisance removed. One case of typhoid fever. One case of measles which was looked after and the disease did not spread.

1897. One case each of scarlet fever and typhoid.—G. E. Parker, Sec.

GREENFIELD. No infectious diseases in either year. Two nuisances removed.—A. D. Littlefield, Sec.

GREENVALE PLANTATION. 1896. Three cases of diphtheria.

1897. Ten cases of diphtheria.—Frank Hight, Sec.

GREENVILLE. 1896. One nuisance removed. One case of scarlet fever. 1897. No cases of diphtheria, scarlet fever, or typhoid.—W. A. Hill, Sec.

GREENWOOD. 1896. No infectious diseases. 1897. One nuisance removed. One case of diphtheria.—A. C. Libby, Sec.

GUILFORD. 1896. Four nuisances, all of which were removed. One case of measles. 1897. Two cases of scarlet fever. Better drainage would be a good idea for our town.—John Scales, Sec.

HALLOWELL. 1896. Fifteen nuisances, all of which were removed. One case of diphtheria and eight of typhoid fever. Measles during the summer.

1897. Ten or more nuisances, not so many as in former years, were reported. They were all removed. One case each of diphtheria and typhoid.—Frank Atkins, Sec.

HAMLIN PLANTATION. We had no contagious diseases in the two years.—John Cyr, Sec.

HAMMOND PLANTATION. No infectious diseases.—John S. Snell, Sec.

HAMPDEN. 1896. Two cases of typhoid fever. Better care of schoolhouses would improve the condition of public health.

1897. Two nuisances, both of which were removed. Four cases of diphtheria, two of scarlet fever, and six of typhoid. Measles in November and December. Vaccination is urgently needed.—Dr. W. H. Nason, Sec.

HANOVER. 1896. No infectious diseases. 1897. Two cases of scarlet fever.—C. B. Frost, Sec.

HARMONY. 1896. Two nuisances removed. One case of typhoid. We have looked after the schools and have found them in a good, healthy condition.

1897. No infectious diseases, except measles in March and April.—W. W. Jacobs, Sec.

HARPSWELL. 1896. Five nuisances were removed. Thirty-nine cases of diphtheria and two each of scarlet fever and typhoid. In the early part of October, a girl ten years of age died of diphtheria. A week before her death a girl of the same age died from a disease of the throat which presented about the same symptoms, which the local doctor called tonsilitis. In my opinion the disease was brought here in July by a family which came from Waltham. The children were troubled with some kind of throat disease. The children of a family near them a while after they came were taken sick, one after another, apparently with the same disease. This was also called tonsilitis. Other children had the same disease. After school began in September, diphtheria broke out in several families about the 8th or 9th of October. Ten houses were placarded. It is probable that some of the children who were said to have tonsilitis had diphtheria, and they spread it broadcast about two miles. I was away at the time and J. S. Farr was appointed to fill the vacancy during my absence. After my return I deemed it best to retain him upon the board. We had a hard fight. The schools, churches, and all places of amusement were closed.

Books were destroyed, schoolhouses were disinfected, as well as churches and public halls. In most cases antitoxin was used and I can say that it had a wonderful effect in checking the disease.

1897. Three nuisances were abated. Four cases of diphtheria and two of typhoid. In this case the disease was supposed to have been brought from another Massachusetts town.—Augustus Sylvester, Sec.

HARRINGTON. 1896. Two cases of scarlet fever and one of typhoid. 1897. One nuisance removed. Four cases of scarlet fever and fourteen of typhoid. Measles was prevalent during the summer and fall.—E. R. McKenzie, Sec.

HARRISON. No infectious diseases. One nuisance removed. —Alphonso Moulton, Sec.

HARTFORD. 1896. One nuisance removed. One case of typhoid fever, two of scarlet fever, and one of typhoid.—Dr. L. H. Maxim, Sec.

HARTLAND. 1896. Four nuisances removed. Three cases of typhoid fever. In two cases, the patients were brought home sick.—E. K. Fuller, Sec.

1897. Four cases of scarlet fever and two of typhoid.—A. H. Buck, Sec.

HAYNESVILLE. 1896. Two nuisances removed. No infectious diseases.—J. E. McCready, Sec.

1897. One case of diphtheria and one case of measles.—J. F. Bryson, Sec.

HEBRON. 1897. One case each of diphtheria and typhoid fever.—Sylvanus Bearce, Sec.

HERMON. 1896. Five cases of diphtheria and one of typhoid. 1897. One nuisance removed. Eight cases of scarlet fever and one of typhoid.—Dr. F. P. Whitaker, Sec.

HERSEY. One nuisance removed. No infectious diseases in the two years.—L. M. Davis, Sec.

HIGHLAND PLANTATION. No infectious diseases in the two years.—J. R. Ryant, Sec.

HIRAM. 1896. Two cases of typhoid fever. 1897. One nuisance removed. One doubtful case of typhoid fever.—Dr. C. E. Wilson, H. O.

HODGDON. No cases of infectious diseases, save one of diphtheria in 1896.—Moses Benn, Sec.

HOLDEN. 1896. One nuisance removed. One case of typhoid fever. Whooping cough in the fall.—G. C. Wiswell, Sec.

1897. No contagious diseases except measles.— G. W. Clark, Sec.

HOLLIS. 1896. One case of typhoid fever. 1897. Two cases of diphtheria, one of typhoid, and a few cases of measles.—S. G. Rumery, Sec.

HOPE. No infectious diseases in 1896, but we had two cases of scarlet fever this past year, and whooping cough was prevalent in the early part of the year.—H. H. Payson, Sec.

HOULTON. 1896. About fifty nuisances were removed. Three cases of diphtheria, seven of scarlet fever, and twenty-eight of typhoid.—Dr. T. J. Fitzmaurice, Sec.

1897. About fifty nuisances were reported to the board, all of which were removed. One case of scarlet fever, and seventeen of typhoid. Some cases of whooping cough.—Dr. C. E. Williams, Sec.

HOWLAND. One nuisance removed in each of the two years. We have had no infectious diseases. Our schoolhouses are small and crowded.—H. N. Weymouth, Sec.

HUDSON. 1896. No infectious diseases, except one case of measles. 1897. One nuisance removed. One mild case of typhoid fever.—A. J. Gardiner, Sec.

HURRICANE ISLE. Two nuisances removed in 1897. No infectious diseases.—J. H. Landers, Sec.

INDUSTRY. No infectious diseases.—W. L. Rackliff, Sec.

ISLAND FALLS. 1896. Two cases of diphtheria and two of typhoid.—S. R. Crabtree, Sec.

1897. Two nuisances removed. Nine cases of typhoid fever. A better system of sewerage would improve our condition.—W. S. Leavitt, Sec.

ISLE AU HAUT. No infectious diseases. Our town is small and everything is in a good, healthy condition.—Edwin Rich, Sec.

ISLESBORO. 1896. Three cases of typhoid fever. We had an outbreak of jaundice and of mumps in our schools.

1897. Three nuisances removed. Eighteen cases of diphtheria and one of typhoid. Antitoxin was used for the diphtheria cases with great success. In the case that died the

parents would not allow it to be used until it was too late.—Dr. E. D. Williams, Sec.

JACKMAN PLANTATION. 1897. Two nuisances removed. Four cases of typhoid. Measles in May and June, and whooping cough in February.—Dr. T. J. Murphy, Sec.

JACKSON. No infectious diseases reported in either year.—M. S. Stiles, Sec.

JAY. 1896. Twenty-five cases of typhoid fever. At North Jay we had the wells which furnished water for the boarding houses stoned up in cement and built up to keep out the surface water, and at that place the number of cases of typhoid fever decreased from sixteen in 1895 to three in 1896.

1897. Fifteen cases of typhoid fever.—H. H. Allen, Sec.

JEFFERSON. We had measles in 1896, but we have had no cases of diphtheria, scarlet fever, or typhoid. Four cases of cerebro-spinal meningitis. 1897. No contagious diseases.—J. J. Bond, Sec.

JONESBORO. 1896. No infectious diseases. 1897. One case of typhoid fever.—John F. Lord, Sec.

JONESPORT. 1896. Four cases of scarlet fever. The outhouses in connection with our schoolhouses need more attention than they receive.—N. Guptill, Sec.

KENDUSKEAG. 1896. One nuisance removed. One case of diphtheria and three of typhoid. 1897. One nuisance removed. One case of typhoid.—Dr. J. F. Benjamin, Sec.

KENNEBUNK. 1897. We have introduced a water supply which proves very satisfactory. About a dozen nuisances were removed. Three cases of diphtheria, six of scarlet fever, and four of typhoid. A system of sewerage is a great necessity, especially since the water-works have been put in.—Dr. F. M. Ross, H. O.

KENNEBUNKPORT. 1896. A system of public water-works has been introduced, but there has been no improvement in the sewerage. Of twelve nuisances, nine were abated. One case of diphtheria, nine of scarlet fever, and one of typhoid. As we have a large and growing village which is a popular summer resort, with from 2,000 to 3,000 visitors each summer, an efficient sewerage system is demanded.

1897. Ten nuisances were reported to the board, of which nine were removed. One case of diphtheria.—Dr. A. W. Langley, Sec.

Kingfield. 1896. Eight nuisances, of which seven were abated. One case of typhoid fever.—W. B. Small, Sec.

1897. A system of water supply is in process of construction. One nuisance was abated. Four cases of typhoid fever, of which three were imported.—Frank Hutchins, Sec.

Kingman. 1897. No cases of infectious diseases, except two of scarlet fever.—Dr. B. R. Somerville, Sec.

Kingsbury Plantation. No infectious diseases, except measles in 1897. One nuisance abated.—Chas. Strickland, Sec.

Kittery. 1896. Three nuisances abated. Two cases of typhoid fever.—Dr. E. E. Shapleigh, Sec.

1897. Six cases of diphtheria, two of scarlet fever, and one of typhoid.—S. B. Neal, Sec.

Knox. 1896. Two cases of diphtheria and two of typhoid.

1897. No infectious diseases, except measles and whooping cough.—J. H. Brown, Sec.

Lagrange. 1896. One nuisance abated. No infectious diseases. 1897. Three cases of diphtheria. The work of the board would be more efficient if cases of infectious diseases were promptly reported to it.—P. E. Speed, Sec.

Lake View Plantation. 1896. We had quite an outbreak of measles which broke up our schools, and a few cases of whooping cough in November.—C. M. Butler, Sec.

1897. One nuisance abated. No infectious diseases reported. —Ai Clapp, Jr., Sec.

Lakeville Plantation. No infectious diseases, except two cases of diphtheria in 1897.—James Ham, Sec.

Lamoine. In the two years there were no cases of infectious diseases. One nuisance abated.—N. D. King, Sec.

Lang Plantation. No infectious diseases, except measles. —R. O. Dyer, Sec.

Lebanon. 1896. Two nuisances abated. Two cases of diphtheria and six of scarlet fever. Whooping cough.—A. H. Ricker, Sec.

1897. Three cases of diphtheria.—S. D. Lord, Sec.

Lee. 1896. No infectious diseases. 1897. Five cases of diphtheria.—Nathan Averill, Sec.

Leeds. 1896. Two cases of scarlet fever.—C. H. Foster, Sec.

1897. One nuisance abated. Nine cases of diphtheria and one of typhoid.—E. A. Mills, Sec.

LEVANT. No cases of diphtheria, scarlet fever, or typhoid in the two years.—John White, Sec.

LEWISTON. 1896. New sewers have been put in the city in various places. About twenty-five nuisances were reported to the board, and all those found to be such were abated. Nine cases of diphtheria, eighty-one of scarlet fever, and ten of typhoid. The same precautions are taken with membranous croup as with any other case of diphtheria. The prevalence of scarlet fever was in the last four months of the year. Among the special improvements made was the putting in of many water-closets in the place of privies.—Dr. H. H. Purinton, Sec.

1897. Many nuisances have been reported to the board, about one hundred probably, and all have been attended to. We have had ninety-nine cases of diphtheria, nineteen of scarlet fever, and two of typhoid. Ten cases of measles were also reported to the board.—Geo. A. Callahan, Sec.

LEXINGTON PLANTATION. No infectious diseases.—A. J. Lane, Sec.

LIBERTY. No infectious diseases, except one case of diphtheria in 1896.—W. H. Moody, Sec.

LIMERICK. 1896. One case of typhoid fever. 1897. One nuisance was abated. No infectious diseases.—Dr. S. D. Chellis, Sec.

LIMESTONE. Twenty cases of typhoid fever in 1896, and four in 1897. We have had no other infectious diseases.—Dr. A. D. Hatfield, Sec.

LIMINGTON. 1896. Five cases of typhoid fever.—L. P. Thompson, Sec.

1897. Two cases of diphtheria, one of scarlet fever, and three of typhoid.—L. J. Strout, Sec.

LINCOLN. 1896. Five cases of scarlet fever. Whooping cough in the spring. 1897. Four nuisances, of which three were abated. Twelve cases of scarlet fever. A sewer is needed in this village.—Dr. C. Fuller, Sec.

LINCOLN PLANTATION. No infectious diseases in the two years.—H. G. Bennett, Sec.

LINCOLNVILLE. 1896. Three nuisances abated. Seven cases of scarlet fever, but none of the other diseases.

1897. Four nuisances abated. Two cases of diphtheria, seven of scarlet fever, and one of typhoid.—Dr. E. F. Brown, Sec.

LINNEUS. 1896. Two cases of typhoid fever. 1897. Five cases of typhoid fever.—Dr. Robt. Boyd, Sec.

LISBON. 1897. A sewer has been put in on Main Street. Six nuisances, all of which were removed. Thirty-five cases of diphtheria and one of scarlet fever.—Edward Berry, Sec.

LITCHFIELD. 1896. No infectious diseases, except two of scarlet fever. 1897. Three nuisances removed. Two cases of diphtheria, two of scarlet fever, and one of typhoid.—Gardiner Roberts, Jr., Sec.

LITTLETON. 1896. Four cases of typhoid fever and a few of whooping cough. 1897. One nuisance removed. No infectious diseases.—W. P. Curtis, Sec.

LIVERMORE. 1896. One nuisance removed. One case of diphtheria, and eleven of scarlet fever. Measles and whooping cough in the winter.

1897. Two nuisances reported, one of which was found to be genuine and was removed. No cases of infectious diseases, except a few of measles and whooping cough.—F. H. Boothby, Sec.

LONG ISLAND PLANTATION. No infectious diseases.—W. S. Rich, Sec.

LOVELL. No infectious diseases in the two years, except one case of scarlet fever and some cases of mumps.—Dr. C. P. Hubbard, Sec.

LOWELL. No infectious diseases, except one case of typhoid in 1897.—F. L. Scammon, Sec.

LUBEC. 1896. Four nuisances, of which three were abated. Two cases of typhoid fever. 1897. One nuisance abated. One case of diphtheria and three of typhoid.—C. M. Fountain, Sec.

LUDLOW. 1896. Six cases of scarlet fever, one of typhoid, and one of whooping cough.—Abner Chase, Sec.

LYMAN. No infectious diseases, except two cases of scarlet fever in 1897.—F. E. Tripp, Sec.

MACHIAS. 1896. Twelve cases of typhoid fever. Jaundice was prevalent.

1897. One nuisance abated. Five cases of typhoid fever, but none of the other diseases. The ventilation in our high and

grammar school-rooms is almost too bad for the pupils or teachers to do good work.—Dr. F. H. Crocker, Sec.

MACHIASPORT. No infectious diseases during the two years, with the exception of one case of diphtheria.—C. W. Robinson, Sec.

MACWAHOC PLANTATION. 1897. No infectious diseases.—D. Alexander, Sec.

MADAWASKA. 1897. One case of scarlet fever and two of typhoid. One nuisance abated.—R. A. Daigle, Sec.

MADISON. 1896. Eight cases of typhoid fever. 1897. One case each of diphtheria and scarlet fever, and two of typhoid.—E. C. Town, Sec.

MADRID. 1897. No infectious diseases, excepting two cases of measles and whooping cough in four families.—L. C. Witham, Sec.

MAGALLOWAY PLANTATION. 1896. No diseases of any kind for the past year.—Lewis Leavitt, Sec.

MANCHESTER. No cases of infectious diseases have come to the notice of the board, except one case of typhoid fever in 1897.—G. M. Knowles, Sec.

MAPLETON. 1896. Three nuisances removed. Two cases of scarlet fever and five of typhoid.—L. W. Hughes, Sec.

1897. One nuisance abated. Eighteen cases of diphtheria. Seventeen dwelling houses, two churches, and one schoolhouse were infected. The prevalence of diphtheria was from August to October. One schoolhouse was closed, the books of the infected pupils were destroyed, and the house was disinfected. Antitoxin was used on part of the patients with good effect. This year is the first time that the quarantine laws have had to be put into effect. If another outbreak should occur, we could control it better.—O. J. Higgins, Sec.

MARIAVILLE. No infectious diseases in the two years.—G. W. Black, Sec.

MARION. No infectious diseases reported.—B. L. Smith, Sec.

MARSHFIELD. No infectious diseases.—L. B. Thaxter, Sec.

MARS HILL. 1896. Three cases of diphtheria. 1897. Three cases of typhoid fever.—B. F. Pierce, Sec.

MASARDIS. 1896. No infectious diseases.—F. W. E. Goss, Sec.

MASON. 1896. One nuisance abated. Chicken-pox was the only distemper. 1897. One nuisance abated. No infectious diseases.—A. S. Bean, Sec.

MATINICUS ISLE PLANTATION. 1896. No infectious diseases.—E. A. Young, Sec.

1897. Two mild cases of typhoid.—E. E. Ames, Sec.

MATTAMISCONTIS. No infectious diseases in the two years. —H. C. Roberts, Sec.

MATTAWAMKEAG. 1896. One case of scarlet fever. 1897. Four cases of scarlet fever, and la grippe and mumps.—F. A. Greenwood, Sec.

MAXFIELD. No contagious diseases in the two years. This town generally is quite healthy.—James Wiley, Sec.

MAYFIELD PLANTATION. No infectious diseases. One nuisance abated.—S. A. Chamberlain, Sec.

MECHANIC FALLS. 1896. Four nuisances abated. Two cases of diphtheria, one of scarlet fever, and three of typhoid. The first case of diphtheria was brought from New York.

1897. Four nuisances, all of which were removed. Three cases of diphtheria, fourteen of scarlet fever, and two of typhoid. Houses were quarantined and formaldehyde was used in the disinfecting work. There was some prevalence of measles and whooping cough. Our water supply is not satisfactory, and through the action of the local board the Water Company was induced to put in a filtration plant from which we expect good results.—M. N. Royal, Sec.

MEDDYBEMPS. No infectious diseases.—A. J. Allen, Sec.

MEDFORD. No infectious diseases. Our schoolhouses are poorly ventilated, with pipe running over the heads of the pupils. —S. O. Dinsmore, Sec.

MEDWAY. 1896. One case of scarlet fever. 1897. We have had eighteen or twenty cases of scarlet fever.—A. Hathaway, Sec.

MERCER. No infectious diseases, except one case of scarlet fever in 1897.—C. H. Girdler, Sec.

MERRILL PLANTATION. 1896. One nuisance removed. No infectious diseases.—J. G. Tarbell, Sec.

1897. No infectious diseases, except possibly one or two cases of scarlatina for which no physician was employed and no return was made.—Dr. A. B. Libby, Sec.

MEXICO. 1896. One nuisance removed. Five cases of diphtheria and four of typhoid.

1897. One case of typhoid. School was stopped on account of a threatening epidemic of measles. The education of the public in sanitary matters would render the work of our local board more efficient. If the *Sanitary Inspector* were furnished every family in town, with copies of the law and their duty and reasons therefor, much good would be done.—Dr. H. J. Binford, Sec.

MILBRIDGE. 1896. Improvements have been made in our water supply and drainage. Five nuisances were abated. Three cases of scarlet fever and four of typhoid.

1897. Ten thousand dollars have been expended on our water supply. Three nuisances abated. Four cases of typhoid fever. There has been a marked improvement in the sanitary condition of the town since the creation of the board of health. —Dr. Geo. Googins, Sec.

MILFORD. 1896. Two nuisances abated. No infectious diseases. We are very much in need of some system of sewerage.

1897. Two nuisances removed. Three cases of typhoid fever. While we have had but little sickness during the past year, the board is in constant fear of an epidemic. The town is supplied with a good system of water, but has no sewerage and, as will readily be seen, an outbreak of contagious disease might result disastrously to the town.—Albion Oakes, Sec.

MILO. 1896. No infectious diseases, except whooping cough in November and December.

1897. Two cases of scarlet fever and six of typhoid. A better water supply and drainage is needed.—F. E. Monroe, Sec.

MILTON PLANTATION. 1897. No infectious diseases.—G. E. Brown, Sec.

MINOT. 1896. Five cases of scarlet fever.—N. P. Downing, Sec.

1897. One nuisance abated. No infectious diseases.—J. M. Harris, Sec.

MONHEGAN PLANTATION. 1896. One case of typhoid fever, but none of the other diseases.—S. W. Sterling, Sec.

MONMOUTH. 1896. Four nuisances abated. One case of diphtheria, five of scarlet fever, and two of typhoid. Whooping cough during the autumn and early winter.—Dr. E. P. Marston, Sec.

1897. Two cases of typhoid, but no diphtheria or scarlet fever reported.—J. L. Orcutt, Sec.

MONROE. No infectious diseases for the two years, except two cases of typhoid fever in 1896. One nuisance abated. Two cases of tuberculosis in cows reported to the proper officials.—Franklin Chase, Sec.

MONTICELLO. 1896. Two cases of typhoid fever and whooping cough was prevalent.—L. E. Stackpole, Sec.

1897. One case of typhoid, and whooping cough in August. —J. R. Weed, Jr., Sec.

MOOSE RIVER PLANTATION. No infectious diseases during the two years, except measles in June and July of 1897.—E. E. Colby, Sec.

MORO PLANTATION. No infectious diseases.—L. W. Kilgore, Sec.

MORRILL. 1896. No infectious diseases. The board was called upon to inspect a schoolhouse and found it in an unhealthy and dangerous condition.—Dr. T. N. Pearson, Sec.

1897. One nuisance removed. No infectious diseases. We have but little work. Our principal value seems to be to be ready for what may come to us from abroad.—D. O. Bowen, Sec.

MOSCOW. 1896. We have had eighteen cases of scarlet fever in a mild form. 1897. No nuisance, except two dead animals that were hauled out and left on top of the ground. They were required to be buried. Not a case of contagious disease to report.—A. Burke, Sec.

MOUNT CHASE. No infectious diseases in the two years. We make a house to house inspection in May.—E. A. Cooper, Sec.

MOUNT DESERT. 1896. Four nuisances removed. Oné case of typhoid fever. Measles in March and April, and whooping cough in November. 1897. Two nuisances removed. No infectious diseases.—J. C. Hill, Sec.

MOUNT VERNON. 1895. One nuisance removed. Two cases of scarlet fever and one of typhoid. Upon notification, our

health officer, Dr. Shaw, and the secretary examined a case which was supposed to be tuberculosis in a cow. The case finally proved not to be one of tuberculosis.

1897. No infectious diseases this year.—A. P. Cram, Sec.

NAPLES. 1896. Three nuisances removed. One case of typhoid fever. 1897. Two nuisances abated. No infectious diseases.—P. O. Cannell, Sec.

NEWBURGH. 1896. No infectious diseases, except whooping cough. The board took action to prevent its spreading in the schools. For want of banking, our schoolhouse floors are left cold and with troublesome drafts.

1897. No infectious diseases, except some prevalence of whooping cough in May and June.—Dr. E. C. Newcomb, Sec.

NEWCASTLE. 1896. Two nuisances removed. No cases of infectious diseases. There were some cases of rash which at first were supposed to be scarlet fever.

1897. One nuisance abated. Seven cases of scarlet fever, with some cases of measles.—D. S. Glidden, Sec.

NEWFIELD. No infectious diseases, except four cases of scarlet fever in 1896.—Dr. E. O. Chellis, H. O.

NEW GLOUCESTER. No infectious diseases in the two years, with the exception of whooping cough and an epidemic of measles which was isolated and stopped. One nuisance abated. —W. L. Shurtleff, Sec.

NEWPORT. 1896. One nuisance abated. One case of scarlet fever. Measles was brought from Boston.

1897. First-class sewerage has been put in this season on Mill and Main Streets, about 2,500 feet, and nearly all the buildings on the line are connected. Six nuisances, all of which are abated. No infectious diseases, except measles and whooping cough.—F. M. Shaw, Sec.

NEW PORTLAND. 1897. One case of typhoid, but no cases of diphtheria or scarlet fever.—Elias Hutchins, Sec.

NEWRY. 1897. No cases of infectious diseases, except chicken-pox and mumps.—W. Williamson, Sec.

NEW SHARON. 1896. One nuisance abated. No infectious diseases, except measles and whooping cough in the latter part of the year.—Dr. B. F. Makepeace, Sec.

1897. Two nuisances abated. Two cases of typhoid fever. —F. C. Hale, Sec.

NEW SWEDEN. No infectious diseases, except whooping cough in June and July.—N. E. Ringdahl, Sec.

NEW VINEYARD. 1896. One nuisance abated. One case of typhoid. 1897. One case of typhoid fever.—W. A. Lee, Sec.

NOBLEBORO. 1896. No infectious diseases. 1897. Five cases of diphtheria, nine of scarlet fever, and one of typhoid. These were attended to at once.—B. R. York, Jr., Sec.

NORRIDGEWOCK. 1896. One case of typhoid fever and a few cases of whooping cough. 1897. Five cases of scarlet fever and one of typhoid. A more hearty coöperation on the part of the physicians would render our public health work more efficient.—F. C. Holt, Sec.

NORTH BERWICK. 1896. Three nuisances removed. Two cases of scarlet fever, and measles in April.

1897. Improvements in drainage and sewerage have been made in the village. Two nuisances have been abated. One case of diphtheria and four of typhoid.—H. A. Butler, Sec.

NORTHFIELD. 1897. No infectious diseases.—C. B. Albee, Sec.

NORTH HAVEN. 1896. One case of measles and one of typhoid. 1897. One nuisance abated. No infectious diseases. The town has been unusually free from diseases of all kinds.—F. W. Alexander, Sec.

NORTHPORT. 1896. One case of scarlet fever and a few cases of whooping cough. 1897. No infectious diseases. The members of this board are ready to do their whole duty when occasion requires.—F. A. Rhodes, Sec.

NORTH YARMOUTH. 1896. Two cases of typhoid, but none of the other diseases. 1897. Three cases of diphtheria and one of scarlet fever.—E. D. Loring, Sec.

NORWAY. 1896. We had no cases of diphtheria, but there were about ten cases of scarlet fever and two of typhoid. The health conditions would be improved by putting in a system of sewerage.

1897. One nuisance abated. One case of typhoid fever.—Dr. F. N. Barker, Sec.

NO. 14 PLANTATION, Washington county. No infectious diseases in the two years.—E. R. Phipps, Sec.

NO. 21 PLANTATION, Washington county. No infectious diseases in the two years, except one case of diphtheria in 1897.—C. H. Yates, Sec.

NO. 33 PLANTATION. 1896. No infectious diseases. 1897. One nuisance removed. Three cases of typhoid fever.—J. R. Shuman, Sec.

OAKFIELD. 1896. One nuisance abated. Six cases of scarlet fever.—J. H. Holden, Sec.

1897. One case of typhoid.—C. A. Risteen, Sec.

OAKLAND. 1896. Six nuisances, all of which were removed. Eight cases of scarlet fever and four of typhoid.

1897. Three nuisances removed. Three cases of typhoid. A sewerage system is needed.—Dr. A. W. Plummer, Sec.

OLD ORCHARD. 1896. Fifty-eight nuisances were abated. Eleven cases of scarlet fever, but none of the other diseases. There were some cases of measles. The work of this board would be rendered more efficient by a more stringent control of the milk supply.—R. F. Chalk, Sec.

1897. A new sewer has been put in on Milliken Street. Five nuisances were removed. Three cases of typhoid fever, but none of diphtheria or scarlet fever. A few cases of measles.—Dr. J. A. Randall, Sec.

OLD TOWN. 1896. There has been an extension of the water supply and the sewerage system. Thirty-six nuisances were abated. Four cases of scarlet fever and six of typhoid.

1897. Twelve nuisances, of which ten were abated. Three cases of diphtheria. No disease has been unusually prevalent.—H. M. Dickey, Sec.

ORIENT. No infectious diseases in the two years.—Daniel Maxwell, Sec.

ORLAND. No infectious diseases in the two years, except one case of typhoid fever.—Frank Buck, Sec.

ORNEVILLE. 1896. Four cases of scarlet fever. 1897. No infectious diseases.—Llewellyn Sanborn, Sec.

ORONO. 1896. One nuisance removed. One case of typhoid fever. 1897. Four nuisances removed. One case of typhoid fever.—W. C. Taylor, Sec.

ORRINGTON. 1896. Two cases of diphtheria.—G. B. Tibbetts, Sec.

OTIS. 1896. No infectious diseases.—J. R. Grant. Chr.

OTISFIELD. 1896. One nuisance removed. One case of typhoid fever. 1897. Four nuisances, of which three were

removed. No infectious diseases, excepting measles in one family.—E. B. Jillson, Sec.

OXBOW PLANTATION. 1896. No infectious diseases.—M. D. Arbo, Sec.

OXFORD. 1897. Four nuisances removed. One case of scarlet fever and two of typhoid. Whooping cough was quite prevalent in the spring.—E. V. Walker, Sec.

PALERMO. 1896. No infectious diseases.—Dr. M. Delany, Sec.

PALMYRA. No infectious diseases in the two years. One nuisance removed.—G. W. Hanson, Sec.

PARIS. 1896. Six nuisances removed. Four cases of scarlet fever, but none of the other diseases.

1897. Eight nuisances, all of which were removed. One case of diphtheria and six of typhoid. Our town is sadly in need of sewerage.—Dr. Horatio Woodbury, Sec.

PARKMAN. No infectious diseases in the two years. Five nuisances abated.—N. M. Cobb, Sec.

PARSONSFIELD. 1896. Two nuisances abated. No infectious diseases. 1897. Twenty-six cases of scarlet fever, but none of the other diseases.—Dr. F. G. Devereux, Sec.

PASSADUMKEAG. 1896. No infectious diseases.—Dr. E. H. Stanhope, H. O.

1897. No contagious diseases.—P. G. Haynes, Town Clerk.

PATTEN. 1896. Two nuisances, one of which was abated. Six cases of typhoid fever.—Dr. W. T. Merrill, Sec.

1897. One case each of diphtheria and of scarlet fever. In both instances the disease was confined to those particular cases. The case of scarlet fever was brought here by a young lady who came to work in a family and who had previously been exposed to the disease without knowing it.—Dr. B. C. Woodbury, Sec.

PEMBROKE. 1896. Eight cases of typhoid fever. 1897. Three cases of typhoid fever.—Dr. J. C. Rogers, Sec.

PENOBSCOT. We had twenty-one cases of scarlet fever and one case of typhoid.

1897. Two nuisances abated. Twelve cases of scarlet fever, and some cases of whooping cough and measles. In one particular we mark a decided improvement each year and that is in

the willingness with which the people submit to the arbitrary quarantine regulations required in contagious diseases.—J. H. Littlefield, Sec.

PERHAM. 1896. One nuisance, which was abated. Twelve cases of scarlet fever. 1897. Two cases of typhoid fever, and whooping cough from August to November. Our public health work would be rendered more efficient by the coöperation of the heads of families with our board of health where disease exists. —F. L. McIntyre, Sec.

PERKINS. 1897. No infectious diseases.—C. W. White, Sec.

PERRY. 1897. No infectious diseases.—G. W. Clark, Sec.

PERU. No infectious diseases, with the exception of one case of typhoid.—O. O. Tracy, Sec.

PHIPPSBURG. 1896. Thirty-five cases of scarlet fever and three of typhoid.—M. H. Ferguson, Sec.

1897. One nuisance abated. Thirteen cases of scarlet fever. Dr. A. F. Williams, Sec.

PITTSFIELD. 1897. Two cases of diphtheria, one of scarlet fever, and eight of typhoid. Measles was prevalent, especially in the spring.—Dr. T. N. Drake, Sec.

PITTSTON. 1896. Two nuisances abated. Nineteen cases of diphtheria. 1897. One nuisance abated. Seven cases of diphtheria, three of scarlet fever, and five of typhoid.—F. B. Gould, Sec.

PLYMOUTH. 1896. No infectious diseases.—Dr. Arthur Macomber, Sec.

POLAND. 1896. Eighteen cases of scarlet fever. Whooping cough was prevalent. 1897. Five cases of diphtheria and one case of measles reported. Some of the schoolhouses that were in an unhealthful condition were improved at the request of the board of health.—Dr. Jason Walker, Sec.

PORTAGE LAKE PLANTATION. 1897. Fourteen cases of scarlet fever and one of typhoid. German measles in the spring.—Fred Bolstridge, Sec.

PORTER. 1897. Two cases of typhoid and one of scarlet fever. Measles was also prevalent.—Dr. E. R. Chellis, Sec.

PORTLAND. 1896. Two meetings of the board were held nearly every week. One hundred twelve cases of diphtheria,

one hundred eleven of scarlet fever, and seventy-seven of typhoid. The unusual prevalence of scarlet fever and diphtheria was in the months of November and December.—Edwin L. Dyer, Sec.

POWNAL. 1896. A very healthful year. No infectious diseases. 1897. One case of typhoid, and measles was prevalent in a mild form.—Dr. S. A. Vosmus, Sec.

PRENTISS. 1896. One case of scarlet fever. 1897. Two cases of diphtheria.—W. H. Thompson, Sec.

PRESQUE ISLE. 1897. Four nuisances, all of which were removed. Two cases of diphtheria and two of typhoid fever. The public health work of the board would be rendered more efficient by improved methods of disposing of refuse and dead animals. We must have some method of cremating such material.—Dr. Frank Kilburn, Sec.

PRINCETON. 1896. Two slight cases of scarlet fever. 1897. Three nuisances abated. Thirteen cases of diphtheria and one of typhoid. The cases of diphtheria were mostly in a mild form.—Dr. S. G. Spooner, Sec.

PROSPECT. 1895. No infectious diseases, except whooping cough in one school. 1897. One case of typhoid, but none of the other diseases.—A. A. Ginn, Sec.

RANDOLPH. 1896. Four nuisances abated. Six cases of diphtheria and three of typhoid. The health of our village would be improved by sewers. 1897. Two nuisances abated. One case of typhoid fever, and measles in May and June.—B. A. Cox, Sec.

RANGELEY. 1896. Twenty cases of diphtheria, but none of the other diseases. 1897. One nuisance abated. Twenty-one cases of diphtheria. There were also four cases of measles.—Dr. S. A. Ross, Sec.

RANGELEY PLANTATION. 1896. One case of diphtheria, and whooping cough in August. 1897. One case of diphtheria, and some cases of measles in June.—E. M. Giles, Sec.

RAYMOND. 1896. Two cases of diphtheria. 1897. Six cases of diphtheria and two of typhoid.—G. M. Leach, Sec.

READFIELD. 1896. Six nuisances abated. One case of diphtheria and two of typhoid. Whooping cough in September and October. 1897. No infectious diseases, except whooping cough.—Dr. W. A. Wright, Sec.

REED PLANTATION. 1897. One nuisance abated. No infectious diseases.—A. B. Prouty, Sec.

RICHMOND. 1896. Three nuisances abated. Eight cases of typhoid fever and a few cases of measles.

1897. Some improvements in regard to drainage have been made in several localities in accordance with the suggestions of the board of health. Two nuisances were abated. Twelve cases of typhoid fever and two mild cases of whooping cough. A most efficient help to the work of the board would be a complete system of sewers for the entire village. It is not hard to see that as the community becomes better informed as to the safety and benefit arising from a knowledge of the sanitary laws and the observance of them, the work of the board would be rendered more efficient and satisfactory.—Dr. D. S. Richards, Sec.

RIPLEY. No infectious diseases in the two years, except two cases of typhoid fever.—A. G. Farrar, Sec.

ROBBINSTON. 1897. Three nuisances abated. Two cases of typhoid fever.—F. R. Leach, Sec.

ROCKLAND. 1896. Thirty-seven nuisances, of which twenty-five were abated. Eight cases of diphtheria, twenty-five of scarlet fever, and three of typhoid. Measles was prevalent from January to May, and whooping cough in the latter part of the year. The health conditions of the city would be improved by extending the sewers to the complete system already mapped out by the city engineer.

In February two mild cases of diphtheria occurred in one family. Two other cases occurred in neighboring families. A few years ago there was a case of diphtheria in this same neighborhood, but it was not reported nor was the house disinfected. Many think that the four cases mentioned originated in this house which was not disinfected. In October, a woman with a child came from a neighboring town to visit a relative. The family where she had lived had just recovered from tonsilitis. Four days after her arrival in this city, diphtheria began in the family to which she had come and three deaths occurred. After this house had been disinfected, a potted plant which had been in the sick-room all the time was taken to a relative in an adjoining town. Some days later this last relative had diphtheria, but recovered. The house was not disinfected and a short time

after her daughter, five years old, had diphtheria and died.—Dr. Benjamin Williams, Sec.

ROCKPORT. 1896. Two cases of diphtheria and some mild cases of whooping cough.—Dr. S. Y. Weidman, H. O.

1897. Four nuisances abated. Two cases each of scarlet fever and typhoid. Our town needs a formaldehyde disinfecting apparatus.—Dr. J. F. Norwood, Sec.

ROME. 1896. Two cases of typhoid fever, and measles and whooping cough were present. 1897. One case of typhoid fever, but none of the other infectious diseases.—E. T. Foster, Sec.

ROQUE BLUFFS. 1896. No infectious diseases. 1897. Two nuisances removed. No contagious diseases.—G. W. Schoppee, Sec.

ROXBURY. 1896. Fifteen cases of measles in the spring and summer, but none of the other diseases. 1897. No contagious diseases in town.—A. W. Robbins, Sec.

RUMFORD. 1896. Our water supply comes from the Androscoggin river. We have a good sewerage system. Thirteen cases of typhoid fever. I think a large part of the cases of typhoid originated at Peterson's Rips where three or four hundred men had been at work building a dam and pulp mill.

1897. Four nuisances abated. Ten cases of typhoid fever, but none of the other diseases, except whooping cough.—F. A. Porter, Sec.

SACO. 1896. Forty nuisances, of which thirty-nine were removed. Seven cases of diphtheria, thirteen of scarlet fever, and sixteen of typhoid.—Dr. W. J. Maybury, Sec.

1897. Fifty-six nuisances, all of which were removed. One case of scarlet fever and nine of typhoid. Measles was prevalent in December.—Dr. C. W. Harwood, Sec.

SALEM. We have had no infectious diseases, except one case of typhoid fever, and measles in one family.—G. E. Willis, Sec.

SANFORD. 1896. Our sewerage has been extended. Two nuisances reported; one abated, the other not considered a nuisance. Three cases of diphtheria, thirteen of scarlet fever, five of typhoid fever, thirteen of measles, and one of cerebro-spinal meningitis. Whooping cough was widely epidemic in the fall. A crematory for the destruction of garbage would render the work of our board more efficient.

1897. Two nuisances abated. Six cases of diphtheria, fifteen of scarlet fever, nine of typhoid fever, and thirteen of measles. A general system of sewerage is needed.—Geo. E. Allen, Sec.

SANGERVILLE. 1896. Five nuisances abated. One case each of scarlet fever and typhoid.—Dr. C. W. Ray, Sec.

SCARBORO. 1896. Two nuisances abated. Fourteen cases of scarlet fever and two of typhoid. 1897. Two nuisances abated. Three cases of diphtheria and four of scarlet fever. Measles in March and July.—Dr. H. H. Allen, Sec.

SEARSMONT. No infectious diseases during the two years, except one case of scarlet fever. One nuisance removed.—L. C. Poor, Sec.

SEARSPORT. 1896. Two nuisances abated. Four cases of scarlet fever and one of typhoid.

1897. Four nuisances removed. No infectious diseases.—Dr. E. H. Durgin, Sec.

SEBAGO. 1896. One nuisance abated. Two cases of typhoid fever. 1897. Two cases of typhoid fever, but none of the other diseases. We had eight cases of measles.—Abram J. Ward, Sec.

SEBEC. No infectious diseases during the two years, except whooping cough.—C. Parker, Sec.

SEBOEIS PLANTATION. No infectious diseases.—C. L. Smart, Sec.

SEDGWICK. 1896. One nuisance removed. Four cases of scarlet fever and three of typhoid.

1897. Two nuisances removed. Eight cases of diphtheria, seven of scarlet fever, and twenty-five of measles. The work of the local board of health would, undoubtedly, be rendered more efficient if they received better pay. Three dollars per year for all my labor and postage stamps is not as it should be.—M. L. Elwell, Sec.

SHAPLEIGH. 1896. No infectious diseases, except several cases of measles and whooping cough. 1897. Four cases of typhoid fever. One nuisance improved.—Dr. W. W. Smith, Sec.

SHERMAN. 1896. One nuisance removed. One case of scarlet fever and three of typhoid. At our April meeting the secretary was instructed to confer with the superintendent of

schools relative to the sanitary condition of the school premises, which was done, and suggestions of the board were faithfully carried out. Good, pure water is secured for all the schools, the water-closets are cleaned, and unsightly rubbish is removed.

1897. One nuisance removed. Two cases of diphtheria, forty-five of scarlet fever, and one of typhoid. The use of Professor Robinson's formaldehyde generator has been adopted by the board and we have arranged with the selectmen to furnish all the material necessary for the thorough cleansing and disinfecting of houses, clothing, etc., at the expense of the town, and find this course far more convenient and effective. There has been a great improvement in the town since the organization of the local board. The State and local boards of health are much more highly appreciated from year to year by the inhabitants of this town as they see a smaller prevalence of contagious diseases in the State than formerly, and the more prompt and thorough measures taken to stamp them out when they appear.—L. C. Caldwell, Sec.

SHIRLEY. No infectious diseases during the two years.—H. Blackstone, Sec.

SIDNEY. 1896. Three cases of scarlet fever, two of typhoid, and some prevalence of measles in the fall. 1897. One nuisance removed. Three cases of scarlet fever and a few cases of measles and whooping cough.—G. R. Campbell, Sec.

SILVER RIDGE PLANTATION. 1896. Two cases of typhoid fever, but none of the other diseases.—Emily L. Dow, Sec.

1897. One case of typhoid fever.—Thos. Clark, Sec.

SKOWHEGAN. 1896. Nine nuisances, all of which were removed or improved. Four cases of typhoid fever, but none of the other diseases. Through the influence of the health officer and the local board of health we got an appropriation for new heating and ventilating plants in the Leavitt Street schoolhouse and the high school building.

1897. There has been some extension of the present system of sewers. Four nuisances, all of which were abated. Eight cases of scarlet fever and two of typhoid, but none of diphtheria. A few cases of measles and whooping cough. All cases of infectious diseases, even chicken-pox and scabies, are excluded

from the schools until cured. Our schools have been remarkably free from contagious diseases, and our sanitary conditions in most respects are very good.—Dr. J. N. Merrill, H. O.

SMITHFIELD. 1896. No cases of infectious diseases.—W. J. Haynes, Sec.

SMYRNA. 1896. Six cases of diphtheria and four of typhoid. —Alden Gerry, Chr.

SOLON. 1897. No infectious diseases.—Dr. S. F. Greene, Sec.

SOMERVILLE. 1897. No infectious diseases.—Morrill Glidden, Sec.

SOUTH BERWICK. 1896. Seventeen nuisances, all of which were removed. Two cases of diphtheria and seven of typhoid.

1897. Twelve nuisances removed. Two cases of diphtheria, one of scarlet fever, and four of typhoid.—G. F. Clough, Sec.

SOUTHPORT. 1896. Two nuisances removed. Three cases of scarlet fever, but none of the other diseases. 1897. No contagious diseases, except one case of measles and some cases of whooping cough.—J. F. Rand, Sec.

SOUTH PORTLAND. 1897. Four nuisances, three of which were abated. Seven cases of diphtheria, twenty-three of scarlet fever, and one of typhoid.—T. B. Haskell, Sec.

SOUTH THOMASTON. 1896. One nuisance abated. One case of diphtheria, fifteen of scarlet fever, but none of typhoid. Measles in the first quarter of the year and whooping cough from July to October.

1897. Two nuisances abated. Three cases of scarlet fever and two of typhoid.—Dr. G. C. Horn, Sec.

SPRINGFIELD. 1896. Eight cases of scarlet fever, but none of the other diseases were present. 1897. Five cases of diphtheria.—Dr. J. R. Varney, Sec.

STACYVILLE PLANTATION. 1896. Three cases of typhoid. 1897. No infectious diseases reported.—J. R. Robinson, Sec.

STARKS. No infectious diseases, except measles in one family and some prevalence of whooping cough.—H. M. Waugh, Sec.

STETSON. No infectious diseases, except six cases of measles. —G. M. Bond, Sec.

STEUBEN. 1896. Four cases of diphtheria, and two each of scarlet fever and typhoid.—B. W. Stevens, Sec.

1897. One case of scarlet fever and one of typhoid.—G. W. Moore, Sec.

STOCKHOLM PLANTATION. No infectious diseases.—Eric A. Larson, Sec.

STOCKTON SPRINGS. No infectious diseases reported.—Dr. G. A. Stevens, Sec.

STONEHAM. 1896. No infectious diseases, excepting a few cases of measles and whooping cough. 1897. Two nuisances abated. One case of scarlet fever and four cases of measles.—N. M. Russell, Sec.

STONINGTON. 1897. Two nuisances abated. One case of diphtheria and seven of scarlet fever.—P. S. Knowlton, Sec.

STOW. No contagious diseases in the two years.—C. W. Day, Sec.

STRONG. 1896. Two nuisances abated. One case of scarlet fever and some cases of measles and whooping cough.—Dr. G. Z. Higgins, H. O.

1897. One nuisance abated. One case of scarlet fever.—W. L. Jones, Sec.

ST. ALBANS. 1896. One nuisance removed. One case of typhoid fever. Whooping cough during the fall. 1897. Two nuisances abated. Two cases each of scarlet fever and of typhoid. Measles was prevalent.—S. B. Prescott, Sec.

ST. GEORGE. 1896. Five cases of diphtheria, six of scarlet fever, and two of typhoid. Measles in February and March. 1897. One case of diphtheria and three of typhoid.—Dr. F. O. Bartlett, Sec.

ST. JOHN PLANTATION. 1897. Five cases of diphtheria, but none of the other diseases.—W. M. Cyr, Sec.

SULLIVAN. 1896. Three cases of typhoid fever, and whooping cough in November and December. 1897. Five cases of typhoid fever. Two outbreaks of measles in July from imported cases.—Dr. F. W. Bridgham, Sec.

SUMMIT PLANTATION. No infectious diseases.—Chas. Curtis, Sec.

SUMNER. 1896. Two nuisances abated. One case of diphtheria, one of scarlet fever, and two of typhoid. 1897. One nuisance abated. No infectious diseases.—Sharon Robinson, Sec.

SURRY. 1896. Two cases of scarlet fever. I think our work has been very satisfactory to the people and there is a growing sentiment in favor of our public health laws. 1897. One nuisance abated. Two cases of typhoid.—H. J. Milliken, Sec.

SWAN'S ISLAND. 1896. One nuisance abated. No infectious diseases, except whooping cough and mumps. 1897. One case of typhoid fever. Measles and whooping cough in the early part of the year.—Dr. H. W. Small, Sec.

SWANVILLE. 1896. No infectious diseases.—A. H. Ellis, Sec. 1897. One case of typhoid, but none of the other diseases.—H. C. Marden, Sec.

SWEDEN. 1896. One case of typhoid fever.—G. S. Marr, Sec. 1897. No infectious diseases reported.—C. W. Bennett, Sec.

TALMAGE. 1897. No infectious diseases.—F. R. Neal, Sec.

TEMPLE. 1896. No infectious diseases.—E. I. Farmer, Sec. 1897. No infectious diseases to the knowledge of the board.—Geo. F. Blodgett, Sec.

THE FORKS PLANTATION. No infectious diseases, excepting whooping cough in 1896.—C. H. Young, Sec.

THOMASTON. 1897. One nuisance abated. Six cases of diphtheria and two of typhoid fever.—Dr. J. E. Walker, Sec.

THORNDIKE. 1896. Three nuisances abated. No infectious diseases.—A. H. Higgins, Sec.

TOPSFIELD. 1896. No infectious diseases, except measles.—O. H. Taylor, Sec. 1897. One case of typhoid.—H. K. Mallory, Chr.

TOPSHAM. 1896. Five nuisances abated. Three cases of scarlet fever and one of typhoid.—Dr. H. O. Curtis, Sec. 1897. Three nuisances removed. Eight cases of scarlet fever, but none of the other diseases reported.—J. C. Purinton, Sec.

TRENTON. 1896. Four cases of scarlet fever.—P. L. Leland, Sec.

TRESCOTT. 1896. No infectious diseases, excepting measles in one family. 1897. One case of typhoid, but none of the other infectious diseases.—John Saunders, Sec.

TROY. 1896. One case each of scarlet fever and of typhoid. Whooping cough in June and July. 1897. One nuisance abated. Three cases of scarlet fever.—Dr. Mark T. Dodge, Sec.

TURNER. 1896. Two nuisances removed. Six cases of scarlet fever, but no other diseases reported. 1897. Four nuisances, of which two were abated. One case of diphtheria and seven each of scarlet fever and measles. We have decided on a drain from our village to the river, which will require the laying of 450 feet of drain pipe.—J. P. Waterman, Sec.

UNION. 1896. One nuisance abated. Four cases of diphtheria and three of scarlet fever. Measles and whooping cough in November and December.—Dr. J. B. Spencer, Sec. 1897. Three cases of diphtheria and five of scarlet fever. Whooping cough in the early part of the year.—Dr. D. M. Wood, Sec.

UNITY. 1896. One case of typhoid fever. 1897. Three nuisances abated. Two cases of diphtheria and one of typhoid. —Dr. J. E. Cook, Sec.

UNITY PLANTATION. No infectious diseases in the two years, except seven cases of measles in 1897.—James A. Brown, Sec.

UPTON. 1897. No infectious diseases during the year.—H. I. Abbott, Sec.

VAN BUREN. 1896. Six cases of diphtheria and some prevalence of whooping cough.—Dr. T. H. Pelletier, H. O.

VANCEBORO. 1896. Two nuisances, one of which was abated. One case of diphtheria, twenty-six of scarlet fever, and one of typhoid. Experience has taught us that promptitude in isolating suspected cases would have prevented the spread of scarlet fever in a great measure.—G. M. B. Sprague, Sec. 1897. Three nuisances abated. Three cases of diphtheria, one case in each of three houses.—G. W. Eales, Sec.

VASSALBORO. 1896. Improvements have been made by carting away débris, and several water-closets and sink drains have been improved. Fourteen cases of diphtheria, two of scarlet fever, and three of typhoid. Measles was prevalent in the winter. 1897. New drains have been opened in the village of North Vassalboro. Of three nuisances reported, two were removed. Three cases of diphtheria and two of typhoid fever. A more thorough system of drainage is needed in the villages.— E. H. Cook, Sec.

VEAZIE. 1896. Three nuisances were removed. No infectious diseases, excepting several cases of whooping cough in May.—G. W. Frost, Sec. 1897. Two nuisances abated. One

case of typhoid fever, which is the only case of contagious disease since our last report.—A. J. Spencer, Sec.

VERONA. 1897. No contagious diseases whatever.—A. H. Whitmore, Sec.

VIENNA. No infectious diseases in the two years, excepting a few cases of measles. One nuisance abated.—E. N. Allen, Sec.

VINALHAVEN. 1896. Seven nuisances were abated. No infectious diseases, except thirty-nine cases of scarlet fever, and no death from that disease. 1897. Eight nuisances, all of which were removed. Thirteen cases of scarlet fever, but no cases of diphtheria or typhoid fever. Of typhoid fever, we have not had a half dozen cases in thirty years.—Dr. E. H. Lyford, Sec.

WADE PLANTATION. 1896. Two cases of scarlet fever, but none of the other diseases.—L. Curtis, Sec.

WAITE. No cases of infectious diseases in the two years.—J. C. Neale, Sec.

WALDO. We have had no dangerous infectious diseases in the two years, except one case of typhoid.—J. G. Harding, Sec.

WALDOBORO. 1896. One nuisance abated. No infectious diseases.—E. V. Philbrook, Chr. 1897. Eleven cases of diphtheria and four of typhoid.—Dr. J. T. Sanborn, Sec.

WALES. 1896. No infectious diseases, except one case of measles. 1897. Two cases each of diphtheria and of scarlet fever.—E. A. Ham, Sec.

WALLAGRASS PLANTATION. Two cases of diphtheria, but no other contagious diseases reported.—G. F. Labbe, Sec.

WALTHAM. 1896. Eleven cases of scarlet fever, but none of the other diseases. 1897. Two cases of diphtheria and three of scarlet fever.—E. W. DeBeck, Sec.

WARREN. 1896. One mild case of diphtheria and one of typhoid. Measles in the early part of the year. 1897. One nuisance abated. One case of diphtheria, two of scarlet fever, and one of typhoid.—Dr. J. M. Wakefield, Sec.

WASHBURN. 1896. Two cases each of scarlet fever and of typhoid. Both cases of typhoid were imported. 1897. Two cases of scarlet fever, but no cases of diphtheria or typhoid. The work of the board would be rendered more efficient by a more general coöperation of citizens and physicians. The

majority are all right, but a few are indifferent, to say the least. —E. M. Hines, Sec.

WASHINGTON. 1896. Three cases of diphtheria and ten of scarlet fever. Measles in November and December.—T. S. Bowen, Sec. 1897. Two nuisances abated. Ten cases of scarlet fever and one of typhoid.—Dr. S. P. Strickland, Sec.

WATERBORO. No infectious diseases in the two years, except one case of measles.—J. L. Chadbourne, Sec.

WATERFORD. 1897. One case of diphtheria and four of typhoid. Whooping cough in the summer. We have no suggestions to offer, except that if all cases of tuberculosis were reported so that the secretary of the local board could supply the family with literature on the subject and advise in regard to the care of the sputum it would be an advantage.—Dr. F. S. Packard, Sec.

WATERVILLE. 1896. Sixty-two nuisances reported, all of which were removed. Three cases of diphtheria and eleven of typhoid. Measles in October and November. As special work of our local board, I might mention that our milk supply has been carefully inspected, and one hundred fifty-eight tests have been made by the milk inspector, Dr. A. Joly. 1897. Fifty-six nuisances were abated. Four cases of diphtheria, seven of scarlet fever, and five of typhoid. Our board disinfects houses after all contagious diseases.—Dr. A. Joly, Sec.

WAYNE. 1896. One case of diphtheria, two each of scarlet fever and typhoid, and a few cases of measles. 1897. We have had no cases of infectious diseases.—Dr. F. L. Chenery, Sec.

WEBSTER. 1896. Three nuisances, all of which were abated. Two cases of typhoid and several of whooping cough. 1897. Four nuisances were abated. Two cases of diphtheria, one of scarlet fever, and five of typhoid.—J. G. Jordan, Sec.

WEBSTER PLANTATION. No infectious diseases in the two years, except two mild cases of scarlet fever in 1896.—A. S. Leighton, Sec.

WELD. 1897. Three nuisances were abated. No infectious diseases, except whooping cough in the summer.—E. S. Twaddle, Sec.

WELLINGTON. 1897. We have had no cases of infectious diseases, except scarlet fever in a mild form in one family.—O. B. Davis, Sec.

WESLEY. 1896. No cases to report, except one of typhoid fever. 1897. No infectious diseases, except one case of cerebro-spinal meningitis.—Samuel Hawkins, Sec.

WEST BATH. 1897. We have had nothing but measles this year, which caused the closure of one school.—C. W. Campbell, Sec.

WESTBROOK. 1896. Two nuisances, both of which were abated. Fifteen cases of diphtheria, thirty-two of scarlet fever, and six of typhoid. Since the adoption of section 15 in the by-laws, which I herewith enclose, we have no trouble in relation to the cleaning of vaults. 1897. Eight nuisances were abated. Five cases of diphtheria and three each of scarlet fever and typhoid. Measles in October and November. The board keeps on hand a small supply of antitoxin, with appliances for using, for the benefit of poor people.—H. K. Griggs, Sec.

The following by-laws are in operation in the city of Westbrook:

Section 1. On and after the tenth day of June, 1887, no person shall be allowed to construct any cess-pool or other receptacle, or conductor for drainage of filth of any kind, in any locality within the limits of the city where access can be had for drainage to a public sewer. When upon proper complaint made in writing to the Board of Health, any cess-pool, receptacle, or conductor, constructed and maintained prior to the adoption of these orders, shall, after careful and thorough investigation, be adjudged to constitute a nuisance or a source of danger to the public health, such cess-pool, receptacle, or conductor shall forthwith be discontinued and abolished, when the premises upon which said nuisance exists can be connected with a public sewer. When such nuisance exists in localities unprovided with proper street sewers, such provision shall be made for them as the Board of Health may determine.

Section 2. Whenever any reasonable complaint is made in regard to the keeping of swine within the limits of any village in the city, the executive officer of the Board of Health shall order said swine to be removed.

Section 3. Any accumulation of refuse matter, such as swill, waste of meat, shells, bones, decayed vegetables, dead carcasses, excrement, or any kind of offal which may decompose and gen-

erate disease, and thus affect the purity of the air in the immediate vicinity of any dwelling house or place of business, shall be considered a nuisance, and must be removed or disposed of by burial, burning, or otherwise, in such manner that it may not be offensive to the neighborhood wherever located.

Section 4. No diseased animal or its flesh, and no decayed meat, fish, vegetables, or fruit, or impure or adulterated milk, nor impure or adulterated article used as food, shall be sold or offered for sale as food.

Section 5. No privy vault shall be cleaned out between sunrise and sunset without the written permission of the executive officer of the board.

Section. 6. Whenever written complaint shall be made to the Board of Health of this town, signed by not less than three persons, requesting the discontinuance of any privy vault situated near any dwelling house within the limits of this city, it shall be the duty of the Board of Health to forthwith examine the premises complained of, and, if after full investigation the Board of Health shall decide that the privy vault should be abolished, they may order the same discontinued, and water-closets substituted instead, provided convenient access may be had to a public sewer.

Section 7. A public funeral shall not be held for any person who has died of scarlet fever, diphtheria, small-pox, cholera, or typhus fever; and the body of any person who has died of these diseases shall neither be brought within nor carried without the jurisdiction of this board, without permission in writing from the board, nor shall there be a dis-interment of any such body after it has once been buried, without the permission of the board.

Section 8. No dead animal shall, within the jurisdiction of this board, be put into any river, well, spring, cistern, reservoir, stream or pond.

Section 9. No privy vault, cess-pool, or reservoir, into which a privy, water-closet, stable, or sink is drained, except it is water-tight, shall be established or permitted within one hundred feet of any well, spring, or other source of water used for drinking or culinary purposes.

Section 10. All privy vaults, cess-pools, or reservoirs named, shall be cleaned out twice a year, once in the spring, not later

than the 15th of May, and once in the autumn, not earlier than the 15th of October.

Section 11. Earth privies and earth closets, with no vault below the surface of the ground shall be excepted in section 10; but sufficient dry earth or coal ashes must be used daily to absorb all the fluid part of the deposit, and the entire contents must be removed at least monthly.

Section 12. All sewer drains that pass within fifty feet of any source of water used for drinking or culinary purposes, shall be water-tight, and in sandy soil the limit shall be eighty feet.

Section 13. Swine shall be kept in such place and manner as not to be offensive to the persons residing in the vicinity; and their pens and yards must be kept deodorized by the application of dried muck, dry earth, or some other effective absorbent. The same rule, with regard to deodorization applies to horses, cows, and other stock.

Section 14. No drainage of any kind, sink, cess-pool, water-closet, or house drainage of any description shall empty into any public street within the limits of this city.

Section 15. No person shall clean out any privy vault without first obtaining a permit in writing from the local Board of Health. And after the fifteenth of August, 1893, the work of cleaning out vaults must be done by what is known as the "Barrel Method," and some deodorizer which shall be approved by said board must be used.

The following by-law relating to the inspection of milk was adopted October 18, 1897:

It is hereby ordained by the Board of Health of the City of Westbrook as follows, viz.:

Sec. 1. No person shall at any time by himself, his clerk, his servant or agent directly or indirectly sell, or offer for sale any milk or cream within the City of Westbrook, unless the cow from which such milk or cream was taken shall have first been examined by the Board of Cattle Commissioners or by some veterinarian appointed by them or approved by the Board of Health of Westbrook and a certificate filed by such examiner with the secretary of the Board of Health, showing that such cow is healthy and free from disease and such certificate shall remain in force one year.

Sec. 2. Any person violating the above provision shall be deemed guilty of a misdemeanor and upon conviction thereof punished by a fine of not more than fifty dollars.

The above to take effect November 1, 1897.

WESTFIELD PLANTATION. 1896. One nuisance was abated. We have had no cases of infectious diseases. 1897. Three cases of scarlet fever.—J. Frank Taylor, Sec.

WEST FORKS PLANTATION. We have had no infectious diseases, except one case of scarlet fever in 1896. The work of our board would be rendered more efficient if the law would permit the municipal officers of The Forks and West Forks to appoint a joint board of health for the two plantations with the power on the part of the board of appointing a physician as health officer.—F. J. Durgin, Sec.

WEST GARDINER. No infectious diseases in the two years, except measles.—F. E. Towle, Sec.

WESTMANLAND PLANTATION. No infectious diseases, except whooping cough in August, 1897.—Eric Lindberg, Sec.

WESTON. No infectious diseases in the two years.—T. S. Gilpatrick, Sec.

WESTPORT. 1896. No infectious diseases, except nine cases of measles.—J. R. Heal, Sec.

WHITEFIELD. No infectious diseases, except a few cases of measles.—Marcellus Philbrick, Sec.

WHITING. 1896. One case of scarlet fever, but none of the other diseases.—A. M. Crane, Sec. 1897. Twenty-six cases of diphtheria and four of typhoid. Disinfection was carried out with the formaldehyde lamp.—J. A. Gilpatrick, Sec.

WHITNEYVILLE. 1896. One nuisance abated. No cases of diphtheria, scarlet fever, or typhoid.—C. H. Sullivan, Sec. 1897. No infectious diseases.—W. M. Flynn, Sec.

WILLIAMSBURG. No infectious diseases in the two years.—R. J. Williams, Sec.

WILLIMANTIC. No infectious diseases in either year.—C. C. Norton, Sec.

WILTON. 1896. Five cases of typhoid fever. 1897. Two nuisances removed. Three cases of typhoid, but none of the other diseases.—A. B. Adams, Sec.

WINDHAM. 1896. Two cases each of scarlet fever and of typhoid. 1897. One nuisance removed. One case of scarlet

fever, one of typhoid, and a few cases of measles in the fall.—Dr. R. B. Jordan, Sec.

WINDSOR. 1897. No contagious diseases.—C. F. Donnell, Sec.

WINN. 1896. Four cases of scarlet fever in one family. 1897. Three cases of scarlet fever and one of typhoid. The board has been on the lookout to prevent the occurrence of nuisances.—M. F. Scott, Sec.

WINSLOW. 1896. Three cases of diphtheria and two of typhoid. Several cases of measles. 1897. A new system of water supply has been put in on Sand Hill by the Lockwood Company. Three nuisances have been abated. One case of diphtheria, one of scarlet fever, and five of typhoid.—Geo. W. Patterson, Sec.

WINTER HARBOR. 1896. Two nuisances removed. No infectious diseases.—B. F. Sumner, Sec. 1897. Six nuisances, all of which were removed. Two cases of typhoid fever, but none of the other diseases.—R. M. Torrey, Sec.

WINTHROP. 1896. Six nuisances, of which five were abated. One, originating from a creamery, the board has thus far failed to abate. One case of scarlet fever. Measles and whooping cough were also prevalent. 1897. Six nuisances were abated. A sewer has been put in from the creamery to South Pond. One case of diphtheria, four of scarlet fever, and three of typhoid.—Dr. C. A. Cochrane, Sec.

WISCASSET. 1897. Two nuisances were abated. Two cases of scarlet fever, but none of the other diseases reported.—Dr. S. A. Stevens, Sec.

WOODLAND. 1896. Four nuisances, all of which were abated. One case of typhoid fever, but nothing else worse than chicken-pox. 1897. One nuisance abated. Two cases of scarlet fever. Whooping cough in the summer.—M. P. Abbott, Sec.

WOODSTOCK. 1896. One case of scarlet fever in a mild form is everything we have had in the way of infectious diseases.—E. S. Russell, Sec. 1897. Three nuisances abated. One case each of diphtheria, scarlet fever, and typhoid.—G. L. Stephens, Sec.

WOODVILLE. No cases of infectious diseases in the two years.—John Pond, Sec.

WOOLWICH. 1897. No infectious diseases, except measles.—A. B. Thwing, Sec.

YARMOUTH. 1896. Four nuisances, all of which were satisfactorily remedied. Five cases of diphtheria and one of typhoid. In the outbreak of diphtheria it was thought that the disease might have been communicated in the school, but that is doubtful. The books were thoroughly disinfected with formaldehyde; the room was thoroughly washed with corrosive sublimate, and then fumigated with sulphur. No cases afterwards appeared. 1897. Four nuisances were abated. One case of scarlet fever.—L. R. Cook, Sec.

YORK. 1897. Two nuisances, one of which was abated. One mild case of typhoid fever.—Dr. W. L. Hawkes, Sec.

SPECIAL PAPERS.

BACTERIOLOGICAL REPORT UPON FORMALDEHYDE.

F. C. ROBINSON and B. L. BRYANT.

In looking over our work and in reading the accounts of the experiments of others, we often find things that are very hard to explain. Two experiments carried out under the same conditions of temperature, cultures, space, and amounts of aldehyde used, often give very different results. It shows how easily experimenters may be misled, when they make one or two tests with disinfectants upon bacteria in a laboratory, and draw their conclusions from these alone. No matter how carefully the experiments may be made, there will always be an element of variation which is hard to account for. So it has seemed best to carry out a long series of tests with formaldehyde, under as near the same conditions as possible, and then draw our conclusions from a general summary, rather than from individual tests. And also we have tried to find out where other experimenters who have been working in the same line as ourselves have differed in their technique in obtaining other results. So for the past six months over one hundred different tests have been carried out here at the Searles Laboratory, many of them being duplicated as nearly as it is possible to do so. Every precaution, as regards culture-media and cultures, has been taken, and no pains spared to make the results trustworthy, and no loophole left where there might be a possible doubt. All the culture-media have been tested each time before using. The cultures have been examined microscopically and only 18-24 hour growths upon serum, agar, and in bouillon have been employed. Our diphtheria culture, especially, originally obtained from the Board of Health Laboratory of New York, has been kept virulent through daily transplanting and inoculation into guinea pigs. Most of the test objects

have been carefully protected from contamination, all being sterilized before using, and handled with sterilized instruments. After exposure, the greater part of the objects have been placed in the fumes of ammonia for half an hour, to neutralize what little formaldehyde there might be retained in the object and carried over into the bouillon. So all doubt as to the retarding or prevention of growth in that manner has been removed. But, as an added precaution, slips of aluminum have been used for the drying of the germs, as they take up practically none of the disinfectant, and can be easily sterilized by heating to 200° C. in the hot air sterilizer.

From all the growths obtained in the last half of our work, cultures have been made and examined to find out whether they were the result of non-sterilization by the gas, or if the bouillon had become cloudy through accidental contamination. The test objects, after exposure in the experiment room and afterwards to half an hour of ammonia fumes, were dropped into sterile bouillon and placed in the incubator at 37° C. for five days or longer, and then their condition noted and tabulated. The work has been merely a continuation of that done last year and published in the report of the State Board of Health of Maine. Some differences of results are seen when bouillon cultures and cultures upon serum and agar are used. Bouillon cultures of the same organism are easier to kill when the bits of cloth or aluminum are dropped into them and then dried, than when the same organism is scraped from the agar or serum slant and smeared upon the same object. The cause of this is obvious. In the bouillon culture a thin layer of germs is deposited over the whole surface and each individual germ comes into closer contact with the disinfectant. In the smear process, a loopful of germs and albuminous matter is deposited upon the slip, and, upon drying, the outer layer of the mass protects those beneath. The action of the gas would also tend to coagulate the surface, making a very complete protection to the germs beneath; hence, when these are dropped into the bouillon solution, the outer layers soak off and give the unharmed organism a chance to grow. It may be also that the albumen lowers the disinfecting power of formaldehyde as it does that of many

other disinfectants. Also, smears upon solid surfaces like metals and glass are harder to disinfect than those upon cloth or paper; for in the former only one side comes into contact with the gas, and in the latter the open meshes give free circulation and contact to all sides. So the same lamp which will destroy in four hours all germs from a bouillon culture soaked into filter paper or cloth, will not, with certainty, destroy smears upon metal or glass in eleven or twelve hours. So we were much surprised and disturbed when we adopted the aluminum method in our work this year, to find that it did not correspond with our report last year, where we used the filter paper, cloth and bouillon methods. But, upon returning to the first methods, we again obtained the same results. We found the packet suggested by Dr. Wyatt Johnston very convenient for test work. The germs were smeared upon bits of sterilized rubber, and then wrapped in three or four layers of sterilized cloth, and the ends clipped with bits of wire or tin. We at once substituted bits of sheet aluminum for the rubber, as they were easier to sterilize and not so apt to contain sulphur and other ingredients which might tend to weaken the germs, after sometime dried upon them. These could be easily dropped in different places without much danger of contamination, and then could be gathered and their contents dropped, with sterilized forceps, into the media. Bouillon has been found to be the best medium to employ as an after test, as it soaks up and disintegrates the mass of bacteria, so that if all of them are not killed, they have a chance to assert themselves. No difference could be seen in the results whether the test objects were moist or dry when exposed. Bits of cloth placed in a Petri dish, and the bouillon culture turned upon them, and at once exposed, were rendered sterile as quickly as where they had been carefully dried beforehand. This was somewhat of a surprise, and not according to the generally accepted idea. But into anything more than a very thin film of liquid it is very doubtful if penetration could be obtained. Notwithstanding the scepticism of several observers, there can be no doubt but that there is some penetration of the gas. Two layers of cotton cloth offer little resistance, when the room is saturated with the vapors of the aldehyde, and even four or five layers of cot-

ton can be penetrated with a fair degree of certainty. As regards woolens, test objects have been frequently killed through one or two thicknesses of blanket, in the ordinary time of exposure. But you cannot depend upon the certainty of the action of the gas through more than one thickness of cotton cloth. The germs used in the tests were Coli Communis, Klebs-Löffler, Pyogenes Aureus and Tubercle. Our first tests were to find out how long the different organisms would live when dried upon aluminum, Coli Communis from agar 24 hour culture. Loopfuls of the germs were scraped off and smeared upon aluminum slips. After different periods these were dropped into bouillon.

24 hours.	4 tubes.	all turbid.	
5 days	3 "	" "	
6 "	4 "	" "	
7 "	2 "	" "	
8 "	4 "	" "	
37 "	5 "	4 turbid.	1 sterile.

In another series the slips were found sterile in 23 days, but they had been exposed more directly to the light. While the others had been kept in a darker place.

With the Klebs-Löffler, where the slips had been kept from bright light, after 30 days, of three tubes, 2 were turbid and 1 sterile. But after 41 days all were sterile. Frequent trials were made with Klebs-Löffler of several days standing, and almost invariably all gave growths. In the first series of tests the Bowdoin Formaldehyde single generator was used, as in our previous work. But, afterwards, for comparison work, several of the most prominent makes were obtained and tried under the same circumstances, those using the formalin solution, those generating directly from the wood alcohol, and from the solid paraldehyde. The rooms used were the same as those used last year, one of 1,000 cubic feet, the other of 3,000. These open into each other. Two doors lead into the larger room and there are two large windows, and both rooms are heated by steam. The doors and corridors were by no means tight, and no precautions were taken to seal them, in any way. The temperature varied between 50°-80° Fahr. and between those limits but little difference in action was observed. At times the smaller room

was shut off and used alone, and in nearly all the tests with the Bowdoin generator, 1 litre of wood alcohol to 2,000 cubic feet of space was used, and the length of exposure necessary to kill with that amount was aimed at.

Experiment Series C.

These experiments were carried out in the smaller room of 1,000 cubic feet capacity. The test objects were aluminum sterilized, upon which a loopful of the agar or serum culture was smeared as it was scraped from the surface. These were then wrapped in four layers of sterilized heavy cotton cloth, and both ends clipped with bits of tin. The cultures were of Coli Communis and diphtheria from laboratory cultures.

1.

Objects infected from three day serum culture of diphtheria. 500 c. c. of alcohol changed, time 4 hours.

1.	Upon shelf, free	sterile
2.	Slipped into paper tube	growth
3.	Under towel, upon shelf	sterile
4.	Shut in box	growth
5.	In pocket of coat	sterile
6.	In pocket of coat	sterile
7.	Floor, under trousers	growth
8.	Control	growth
9.	Control	growth

2.

Same as above with Coli Communis from 2 day culture, 500 cc. alcohol; time 4 hours.

1.	In paper tube	sterile
2.	Free, upon shelf	sterile
3.	Under towel, shelf	growth
4.	Under trousers, floor	sterile
5.	Pocket of coat	sterile
6.	Pocket of coat	sterile
7.	In box	sterile
8.	Free	sterile
9.	Glass tubes 6 in. long, plugged with cotton	sterile
10	Control	growth

3.

Same with diphtheria, 500 cc. of alcohol; time, 4 hours.

1.	Several layers of towel	sterile
2.	Free, upon shelf	sterile
3.	Free, upon shelf	growth
4.	Between felt, on floor	growth
5.	" "	"
6.	Five layers of canvas	sterile
7.	" "	growth
8.	Glass tube plugged with cotton	sterile
9.	" " "	growth
10.	" " "	growth
11.	Control	growth

4.

Culture of Coli Communis and diphtheria, exposed 12 hours, 500 cc. alcohol.

Diphtheria.

1.	8 layers canvas, floor	sterile
2.	8 layers canvas, on box	"
3.	Coat pocket	"
4.	8 layers of towel	"

Coli Communis.

5.	8 layers canvas, floor	growth
6.	Coat pocket	sterile
7.	Towel, 8 layers	"
8.	8 layers canvas	growth
9.	Control	growth
10.	Control	"

5.

Coli Communis from agar culture, 500 cc. alcohol, 5 hours. Some in packets, some in glass tubes.

1.	Floor, free	growth
2.	Stool, under trousers	"
3.	Floor, free	sterile
4.	Floor, under coat	growth
5.	Shelf, free	sterile
6.	Paper tube, shelf	growth

7.	Glass tube	sterile
8.	"	"
9.	"	growth
10.	"	sterile
11.	"	"

1.

Series D.

Cultures of Coli Communis upon aluminum, wrapped in three layers of sterilized cheese cloth, instead of the heavier cotton cloth. Exposed in two sets, one upon floor, the other upon shelves higher up; none of these had extra coverings. 500 cc. alcohol, 4½ hours.

Upon the floor—5, all sterile

Upon shelf—5 sterile, 1 not sterile, 3 controls, good growth

2.

Same as No. 1. 500 cc. alcohol, 4½ hours.

Upon floor—4, all sterile

Upon shelf—3 sterile, 1 turbid.

Control, turbid.

3.

Coli Communis in packets, also some aluminum slips free in Petri dishes, 475 cc. alcohol, time 12 hours.

Upon floor—6 packets 5 sterile 1 turbid

Upon shelf—5 packets, all sterile

Free in Petri dishes—4 sterile, 1 turbid.

3 controls, all turbid.

4.

Coli Communis in packets upon floor and shelf. Afterwards exposed ½ hour to ammonia. 500 cc. alcohol, time 5 hours. 11 cultures made, all were sterile.

2 controls gave turbidness.

5.

Coli Communis in packets. 500 cc. alcohol, time 14 hours, ammonia ½ hour.

1.	Free, upon floor	sterile
2.	2 layers canvas, floor	"
3.	In newspaper, floor	"
4.	In coat, upon stool	"
5.	2 layers towel, upon shelf	"
6.	In box, upon shelf	"
7.	Free, upon shelf	"
8.	" "	"
9.	Control	growth
10.	Control	"

6.

Serum culture of diphtheria upon aluminum in packets. 500 cc. alcohol, time, 6 hours, ½ hour ammonia.

1.	Free, upon floor	growth
2.	" "	"
3.	" "	"
4.	" "	"
5.	Floor, under paper	"
6.	Floor, under trousers	"
7.	Stool, under coat	"
8.	Shelf, under 2 layers towel	"
9.	" " box	"
10.	" free	"
11.	" "	"
12.	" "	"
	Controls,	3 growths

7.

Diphtheria, all free, upon aluminum slips, in Petri dishes. From serum cultures. Of eleven cultures ten gave growths. 500 cc. alcohol; time, 4 hours, ammonia ½ hour.

8.

Diphtheria cultures from 18 hours serum, in packets. Alcohol, 500 cc., time 6 hours.

1.	5 layers towel	growth
2.	" " "	"
3.	" " "	"
4.	" " "	"

5.	4 layers towel	sterile
6.	" " "	"
7.	" " "	growth
8.	" " "	"
9.	4 layers cheese cloth	sterile
10.	" " " "	growth
11.	" " " "	"
12.	" " " "	"
	2 controls	growth

9.

Same as No. 8. Cultures upon floor, time 14 hours.

1.	5 layers towel	growth
2.	" " "	"
3.	" " "	sterile
4.	" " "	"
5.	4 " "	growth
6.	" " "	sterile
7.	" " "	"
8.	" " "	"
9.	4 layers cheese cloth	"
10.	" " " "	"
11.	" " " "	growth
12.	Control	"

Growths all light, except control.

10.

Diphtheria upon aluminum, exposed free in Petri dishes. 500 cc. alcohol, time 4 hours, ammonia ½ hour.

All were sterile except the two controls.

These two series of experiments were carried on during a very busy time of the year and so had to be rather disconnected. The Coli Communis was used, because it gave quick growths in the test bouillon, and seemed more hardy than the diphtheria culture and not so liable to variation. Several test cultures were made from the tubes, growths being formed in litmus, glucose, and agar, and the characteristic gas and reddening of the medium were taken as evidence of the colon bacillus. Some cultures were examined also microscopically. The two series

showed great variations, some of which were very hard to reconcile. Especially this was the case in Series D., 7 and 10. In both cases the circumstances were exactly the same. In 7 all but one of the slips gave growths, and in 10 all were sterile. The slips were infected with loops of the serum culture, scraped from the surface and touched to the aluminum, sometimes drying as a thick mass. In these cases the infecting was done with two cultures made from the same original culture. Some of the other variations may have been due to the thickness of the layer of germs in the individual cases, or the slips may have been turned so that the contaminated surface came against the bottom of the Petri dish. In the following experiments care was taken to keep the smeared side up.

I.

Series E.

Thirty-two positive cultures of diphtheria were obtained at the Boston City Hospital just as they were used for clinical diagnosis. Loops from the surface of these were smeared upon the aluminum slips and then exposed free in Petri dishes, without any covering whatever, than ½ hour to ammonia fumes under a bell jar. Time of exposure, 7½ hours, alcohol 500 cc.; 89 cultures were made from these; 58 were sterile, and 31 gave growths. From these growths, 19 serum tubes were inoculated, and incubated for 18 hours, and these examined. As all the original cultures were mixed cultures from the throat, our object was to see which of the organisms survived.

1 Cocci
2 " short thick bacillus, few K. L.
3 " Klebs-Löffler
4 " Klebs-Löffler
5 Spore bearer & Klebs-Löffler
6 Short thick bacillus & Klebs-Löffler
7 " " " and smaller one, no Klebs-Löffler
8 K. L. and cocci
9 Short bacillus & Klebs-Löffler
10 Cocci & Klebs-Löffler
11 " " "
12 " " "
13 " " "

14 Klebs-Löffler
15 Cocci
16 "
17 Short lightly stained bacillus
18 Klebs-Löffler & cocci
19 Klebs-Löffler

So, out of 19 cultures, 14 gave Klebs-Löffler, in five, it was absent, and 12 gave cocci.

2.

The large room was used, or, rather, both together, of 4,000 cubic feet capacity. Bits of cloth were smeared with the Boston cultures, and then exposed for six hours. Two litres of alcohol were used. Twenty-four cultures were made, and five controls.

15 gave growths
13 were sterile
5 controls all gave growths.

3.

Aluminum slips smeared with the cultures, and exposed free to the gas in the small room, 1,000 cubic feet; time, 11 hours; 500 cc. alcohol used. Forty-four cultures were made; 37 were sterile, 7 were not sterile. The seven growths were transplanted to serum, and examined, with the following results:

1 Short thick bacillus, cocci and spore bearer.
2 Pure culture cocci
3 Cocci
4 Short thick bacillus, rounded ends, often in pairs.
5 Large cocci, few short thick bacilli.
6 Short thick bacillus, and longer thin ones.
7 Cocci.

In this experiment no Klebs-Löffler survived. In five cultures there were cocci, in four a short thick bacillus.

4.

Diphtheria cultures upon cloth, as in No. 2. Exposed in large rooms, 4,000 cu. ft. Alcohol 2 litres, time 12 hours. Twenty-four cultures made; 21 sterile, 3 gave growths. The

three growths were transferred to serum, incubated, and examined.

1 Cocci and bacilli.

2 Cocci

3 Cocci and bacilli

No Klebs-Löffler survived.

5.

Diphtheria cultures upon aluminum, small room, 500 cc. alcohol, time, 9 hours, ½ hour ammonia.

9	upon floor,	7 sterile,	2 gave growths.
21	" shelf,	19 "	2 " "
		26	4

6.

Diphtheria upon cloth and aluminum exposed in large room, 2 litres of alcohol, time, 8 hours. Of the fifty-two slips, 26 were exposed to ammonia before they were put into the bouillon, the other 26 were not. Of those not exposed, the whole 26 were sterile. The others gave 22 sterile, 4 not sterile.

Several other experiments have been made in the same way and always the differences were in about the same proportion. A few more growths, if any, were obtained when the ammonia was used. In this series all the diphtheria was killed with the single generator, using 1 litre to 2,000 cu. ft., in 11 or 12 hours.

Series F.

In the following tests, with one or two exceptions, all the diphtheria culture used was made from the New York culture. Before using, one cc. of the bouillon culture was found to kill a 400 gram pig in 48 hours. During all the time of experimenting it was transplanted upon serum every other day.

1.

Bouillon culture of Klebs-Löffler 18 hours old was used. Bits of sterilized filter paper soaked in this, also bits of aluminum. These exposed in Petri dishes in large room. Two litres alcohol; time, 5½ hours. A part of the objects were exposed to ammonia. Fifty-seven cultures were made, and all were sterile after 5 days' incubation.

2.

Bits of cloth soaked in bouillon cultures of Klebs-Löffler dried and exposed in large room; alcohol, 2 litres; time, 4 hours. One-half of test objects treated with ammonia, the others not. All were sterile.

These two experiments show how much easier bouillon cultures of the same organism are killed, when used to infect objects. Only four hours were necessary to kill, where in some cases 12 hours failed in the smear method from serum.

Series G.

Several generators of different kinds were obtained through the kindness of the several manufacturers, and a series of experiments made to test the relative merits of each. The generators so used for making the gas direct from the wood alcohol, were the "Moffat," twelve burner, manufactured by the Eli Lilly Co. of Indianapolis, and the double and single Bowdoin generators.

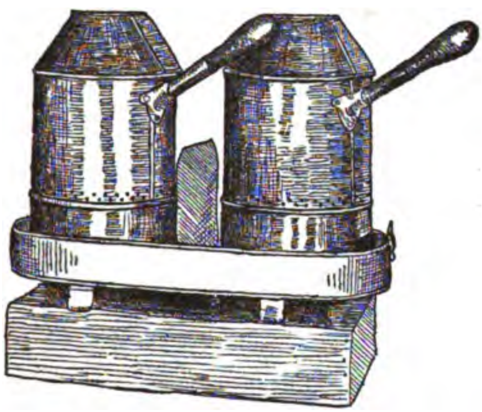
Two forms of the sanitary apparatus were used for generating the gas from the solution of formaldehyde, and the disinfector manufactured by Schering and Glatz for using the solid paraldehyde in form of pastilles, also put up by the same firm. In all the trials, the diphtheria cultures used, were from the same test stock, from 24-48 hour cultures. The same conditions were reproduced as nearly as possible, and the uniform time was five hours for most of the tests, where that time or less was claimed to be sufficient for complete disinfection. The test objects were infected in several ways and were always of two kinds, the aluminum slips, and the bits of sterilized cotton cloth. The aluminum slips were infected with the wire loop, and part of them wrapped in packets of two layers of heavy sterilized cotton cloth. A part of these packets were again wrapped in additional layers of heavy cotton cloth, and the ends folded over and pinned so that the gas would have to pass through the folds of the cloth to reach the germs. Other slips were exposed free in Petri dishes, and the cotton bits were infected with the water of condensation from the bottom of the serum tubes, after the cultures had been washed from the slants into it. This was poured upon the bits of cloth in Petri dishes and exposed direct to the gas. In a few cases these were dried beforehand, but usually they were exposed in a moist condition. The cultures

were neutralized with ammonia before being placed in bouillon. All the test cultures were incubated at 37° C. for five days or over, and then the results tabulated. But one trial was with the Bowdoin single generator. Room 4,000 cu. feet, time 5 hours, alcohol 2 litres.

I.

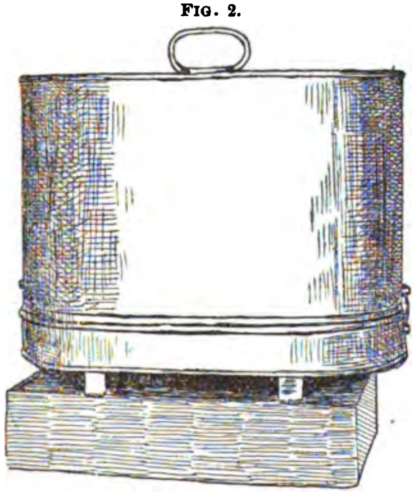
3 in 7 layers of cloth		3 not sterile
3 in 4 layers of cloth	3 sterile	
10 free upon cloth	3 sterile	7 not sterile
11 free upon aluminum	6 sterile	5 not sterile
	—	—
	12	15

FIG. 1.



Bowdoin Generator—Double.

FIG. 2.



Bowdoin Generator—Covered for transportation.

2.

In this trial the double generator was used. In this form there are two cyclinders and disks which change the alcohol twice as fast, and a double amount is poured into the room in the same time. The same amount of alcohol was used, two litres, and the same time of exposure.

3 in 7 layers of cloth		3 not sterile
3 in 4 " "	3 sterile	
9 free upon cloth	9 "	
12 " " aluminum	9 "	3 not sterile

All the following experiments were made in another room of 2,300 cu. feet capacity having two large double windows, quite loose, and two doors.

3.

Double generator, alcohol 1½ litres, time 7 hours.

3 in 7 layers of cloth		3 not sterile
6 " 4 " "	4 sterile	2 " "
9 free upon cloth	8 "	1 " "
9 " " aluminum	6 "	3 " "
	18 "	9 " "

Of the nine giving growths, 4 were Klebs-Löffler, 5 were not.

4.

Double generator, alcohol 1½ litres, time, 5 hours.

2 in 6 layers of cloth	1 sterile	1 not sterile
3 " 5 " "	1 "	2 " "
3 " 4 " "	1 "	2 " "
6 " 2 " "	5 "	1 " "
3 " 2 " " & 1 of blanket	2 "	1 " "
7 free upon cloth	7 "	
	18	7

Six of the growths were Klebs-Löffler.

5.

Double generator, alcohol 1½ litres, time, 5 hours.

2 in 7 layers of cloth	2 sterile

3 in 5 layers of cloth	1 sterile	2 not sterile
3 " 4 " "	3 "	
4 " 2 " "	3 "	1 " "
4 " 2 " " & 1 of blanket	2 "	
	11	3

All the three growths were spore bearers.

6.

Double generator, 1 litre of alcohol, time, 5 hours.

3 in 5 layers of cloth	3 sterile
5 " 2 " "	5 "
2 " 2 " " & 1 of blanket	2 "
9 free upon aluminum	9 "
9 Pyogenus aureus upon cloth	9 "
	28

FIG. 3.

Sanitary Apparatus—No. 1.

7.

Sanitary apparatus No. 1. In this generator the solution of formaldehyde is used mixed with an equal amount of a 20 per cent. solution of calcium chloride. This is then heated in a copper boiler by a lamp beneath, until 45 lbs. pressure is obtained, which opens an automatic valve, and the vapor is blown into room to be disinfected. 350 cc. of formaldehyde were used, and 350 cc. of the 20 per cent. solution of calcium chloride; time, 5 hours.

3 in 7 layers of cloth			3	not sterile
4 " 3 " "	3	sterile	1	" "
9 free upon aluminum	7	"	2	" "
9 " " cloth	5	"	4	" "
	15		10	

8.

Sanitary No. 1. 350 formalin; 350 cc. cal. chloride; time, 5 hours.

3 in 6 layers of cloth	3	sterile		
3 " 5 " "	3	"		
3 " 4 " "	1	"	2	not sterile
5 " 2 " "	4	"	1	" "
9 free upon cloth	9	"		
	20		3	

9.

Sanitary No. 1. 350 formalin; 350 cc. $CaCl_2$; time, 5 hours.

3 in 5 layers of cloth	2	sterile	1	not sterile
3 " 6 " "	3	"		
3 " 4 " "	3	"		
5 " 3 " "	5	"		
	13		1	

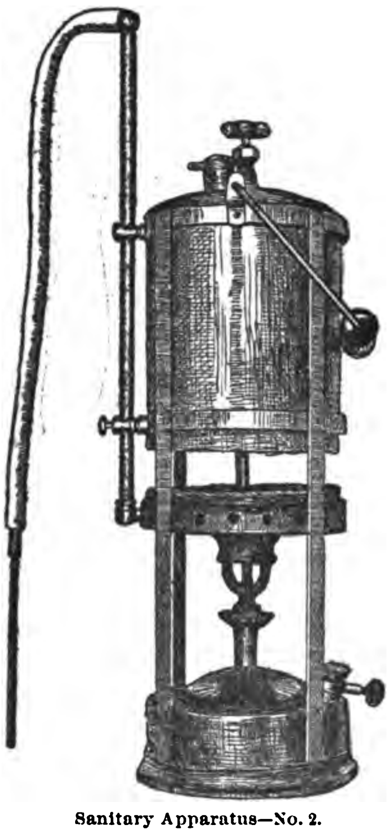
Growth gave Klebs-Löffler.

10.

Sanitary No. 1. 350 cc. formalin; 350 cc. $CaCl_2$; time, 5 hours.

3 in 5 layers of cloth	2 sterile	1 not sterile
5 " 2 " "	5 "	
2 " 2 " " & 1 of blanket	1 "	1 " "
9 free upon aluminum	9 "	
8 Pyogenus aureus	8 "	
	25	2

FIG. 4.



Sanitary Apparatus—No. 2.

II.

Sanitary No. 2. In this form the formalin solution is placed in a copper tank, and runs down through a valve into a copper coil kept red hot by a kerosene vapor lamp. The vapor of the formalin solution is blown through the keyhole into the room.

This apparatus uses about 500 cc. of the formalin solution in one hour. In this first test Pyogenes aureus was used instead of diphtheria. Apparatus ran 25 minutes, room closed 5 hours.

6 in 4 layers of cloth	4 sterile	2 not sterile
7 " 2 " "	3 "	4 " "
8 free upon aluminum	2 "	6 " "
9 free upon cloth	9 "	
	18	12

All growths gave Aureus.

12.

Sanitary No. 2. Ran 28 minutes, room closed 5 hours. Both Aureus and diphtheria were used.

Aureus,

3 in 5 layers of cloth	1 sterile	2 not sterile
3 " 4 " "	1 "	2 " "
4 " 2 " "	2 "	2 " "
4 " 2 " " & 1 of blanket	2 "	2 " "
5 free, upon aluminum	5 "	
5 free, upon cloth	5 "	

Diphtheria,

6 in 2 layers of cloth	6 sterile
5 free, upon aluminum	5 "
5 free, upon cloth	5 "

13.

Sanitary No. 2. Ran 30 minutes, room closed 5 hours, diphtheria cultures.

3 in 5 layers of cloth	3 sterile	
5 " 2 " "	2 "	3 not sterile
2 " 2 " " & 1 of blanket	1 "	1 " "
5 free, upon aluminum	5 "	
	11	4

All growths gave Klebs-Löffler.

14.

Sanitary No. 2. Ran 1 hour in a room of 4,000 cu. feet of space; 500 cc. of formalin; time, 6 hours.

3 in 5 layers of cloth		3 not sterile
8 " 2 " "	8 sterile	
8 free, upon aluminum	8 "	
11 Pyogenes Aureus upon cloth	11 "	
	27	3

15.

Lilly 12 burner Moffat generator was used. This apparatus was filled with the wood alcohol, and allowed to burn in the room of 2,300 cu. ft. for $1\frac{1}{2}$ hours. After this the room was kept closed for 5 hours. Diphtheria cultures were used.

3 in 6 layers of cloth		3 not sterile
8 " 2 " "		8 " "
9 free, upon aluminum	1 sterile	8 " "
9 " " "	1 "	8 " "
	2	27

16.

Moffat generator, burned $1\frac{3}{4}$ hours, room kept closed for 16 hours.

9 in 2 layers of cloth	5 sterile	4 not sterile
9 free, upon aluminum	5 "	4 " "
9 Pyogenus aureus, upon cloth	4 "	5 " "
	14	13

FIG. 5.

Schering & Glatz's Apparatus.

17.

Schering and Glatz's apparatus. The "Disinfector" used in the room of 2,300 cu. ft. capacity. 60 pastils were used; time, 12 hours. Diphtheria cultures were used and Aureus upon cloth.

3 in 5 layers of cloth	1	sterile	2	not sterile
8 " 2 " "	6	"	2	" "
3 " 2 " " & 1 of blanket	2	"	1	" "
8 free, upon aluminum	8	"		
8 Pyogenus Aureus, upon cloth	7	"	1	" "
	24		6	

From the cultures made from the growths, the ones from the 5 & 2 layers of cotton cloth gave Klebs-Löffler. The one from the blanket was not Klebs-Löffler.

Of all the forms of apparatus tested, none of them can be relied upon to sterilize free surfaces in 5 hours with the amount of material advocated by their different manufacturers. At times, as the experiments show, all the test objects free upon aluminum and cloth were sterilized, but at other times, with the same apparatus, and in the same room, they were not. The Bowdoin single generator in the single experiment in this series

failed to kill the free objects in 5 hours. The Bowdoin double generator killed all objects free upon cloth 3 times, and failed once. Upon aluminum, succeeded once, and failed twice. The Sanitary No. 1, free upon cloth failed once and killed all twice. Upon aluminum, failed once, and killed all once. Sanitary No. 2, killed Aureus free upon cloth three times, failed to kill free upon aluminum twice, killed Klebs-Löffler upon cloth once, and upon aluminum twice. The Moffat in its two trials failed both times in both ways in from 5 to 16 hours. The Schering apparatus in its one trial killed free upon aluminum, but failed in the Aureus upon cloth in 12 hours. From these experiments as regards diphtheria, the two generators from the Sanitary Company, and the double Bowdoin Generator seem to be of about equal efficiency. In all three cases, where the room was opened at the end of the first hour it was impossible to enter, the gas was so strong in the room. The rooms used were such as would be found in an ordinary dwelling house, and no precautions, as pasting and sealing, were taken, and we have tried to obtain all the conditions as regards temperature and air currents one would get in ordinary practice. The objects have been placed at the different distances from the floor where infection would be most likely to occur, and find but little difference in the results, whether the objects are on the floor, or four or six feet higher up, as the gas is of nearly the same weight as the air. A series of tests with tuberculosis was begun, and several tests tried. But the control cultures were found to be non-virulent, and so a new series has been commenced, with fresh virulent cultures. This last series of experiments has been more for comparison, and to test the efficiency with the amounts and length of time claimed by the different firms to be efficient. None of them came up to the standard claimed for them.

Series H.

This series was undertaken with the object of finding out the length of time necessary to kill with certainty all the germs in the test objects exposed in a room, and also the amounts of material to be used. The room containing 3,000 cu. ft. was used, and the temperature varied from 12°-15°C. In the first two tests with the Bowdoin Double Generator the results were

not satisfactory, as a poor grade of alcohol, the dregs from a barrel, was used, and but part of it could be changed over with the generator. But even in these cases all Klebs-Löffler upon cloth was killed in 12 hours, though anthrax spores and tubercle were not. The two pigs inoculated from the exposed sputum developed tuberculosis, as also did the control pig, inoculated with the fresh material at the same time.

3.

Double generator using 2 litres of alcohol for 3,000 cu. feet; time, 11 hours. In these tests bits of heavy blanket sterilized and soaked in the cultures were used, together with the other test objects.

Anthrax, with spores,

3	upon cloth	3 sterile	
4	" blanket	4 "	
5	" aluminum	2 "	3 not sterile
3	" " in 2 layers of cloth	1 "	2 " "
2	" " " 5 " "	1 "	2 " "

Diphtheria,

3	upon cloth	3 sterile	
5	" blanket	5 "	
8	" aluminum	7 "	1 not sterile
3	" " in 2 layers of cloth		3 " "
2	" " " 5 " "		2 " "

4.

Sanitary apparatus No. 1, 500 cc. formalin; 500 cc. 20 per cent. calcium chloride solution; time, 12 hours.

Anthrax, with spores,

3	upon cloth	3 sterile	
2	" blanket	2 "	
7	" aluminum	4 "	3 not sterile
3	" " in 2 layers of cloth		3 " "
1	" " " 5 " "		1 " "

5.

Sanitary No. 1. Same as in No. 4; time, 11 hours.

Anthrax, with spores,

2	upon	alum'um in	5 layers of cloth	1 sterile	1 not sterile
3	"	" "	2 " "	1 "	2 " "
3	"	cloth		3 "	
4	"	blanket		4 "	
5	"	aluminum		3 "	2 " "

Diphtheria,

2	upon	alum'um in	5 layers of cloth		2 not sterile
3	"	" "	2 " "	2 sterile	1 " "
4	"	cloth		4 "	
5	"	blanket		5 "	
5	"	aluminum		5 "	

6.

Sanitary No. 2. The tank was filled with a measured amount of formalin, and, after remaining one hour, it was again measured, and it was found that but 320 cc. had been used; time, 12 hours.

Anthrax, with spores,

2	upon	alum'um in	5 layers of cloth		2 not sterile
3	"	" "	2 " "		3 " "
3	"	cloth		3 sterile	
4	"	blanket		4 "	
5	"	aluminum		2 "	3 " "

Diphtheria,

2	upon	alum'um in	5 layers of cloth	2 sterile	
3	"	" "	2 " "	2 "	1 not sterile
3	'	cloth		3 "	
4	"	blanket		4 "	
6	"	aluminum		6 "	

7.

Sanitary No. 2. Ran one hour, and used out 150 cc. formalin. Time, 11 hours.

Anthrax, with spores,

2	upon alum'um in 5 layers of cloth		2	not sterile
2	" " " 2 " "		2	" "
3	" cloth		3	" "
5	" blanket		5	" "
6	" aluminum		6	" "

Diphtheria,

2	upon alum'um in 2 layers of cloth	1 sterile	1	not sterile
2	" cloth		2	" "
4	" blanket		4	" "
5	" aluminum	2 "	3	" "

Upon noticing the marked differences in the amounts blown into a room in the same time by this form of apparatus, a number of tests were tried, both with formalin and water. The apparatus in each case was run one hour with the following results:

1st	500 cc. per hour
2nd	320 cc. "
3rd	380 cc. "
4th	130 cc. "
5th	350 cc. "

6th. In the sixth experiment a call came to disinfect a schoolhouse, and this apparatus with another form was taken. After it had been running for half an hour a door was opened at the other side of the room and it was found that practically no formalin had been injected into the room and beyond a little puff of steam occasionally there was no action whatever. This was either due to the clogging of the inlet hole or to the corroding of the coil.

In the meantime, experiments had been going on here at the laboratory to find some form of apparatus that would do away with the disadvantages of both a high pressure and a complication of valves that are so apt to get out of order and give uncertain results, and at the same time would change into gas a large amount of formalin solution in a very short time. Such a lamp has been made, and successfully used here for some time.

The apparatus uses one litre of the solution per hour, and delivers it into the room at a temperature 200° C, or twice the

FIG. 6.

Bowdoin Vaporizer.

boiling point of water, by actual experiment. It does away with the use of normal salts and requires nothing but the 40 per cent. solution which is boiled by the heat of a lamp, its vapor passing out of the top down the outside tube, and through a coil heated by the same lamp. All the solution is used, and there is no dripping save one or two drops upon first starting. This is called the Bowdoin Vaporizer, and a number of experiments have been tried with it, with the following results:

I.

300 cc. formalin used. Room 3,000 cu. ft. Time, 9½ hours.

Anthrax, with spores,

3 upon cloth	3 sterile
3 " alum'um in 2 layers of cloth	3 not sterile
2 " " " 5 " "	2 " "

Diphtheria,

3	upon alum'um in 2 layers of cloth	1 sterile	2 not sterile
1	" " " 5 " "		1 " "
3	" cloth	3 "	
6	" aluminum	4 "	2 " "

Tubercle sputum upon aluminum and dried in Petri dishes was soaked up in sterile water, and inoculated into a guinea pig. No signs of tuberculosis after three weeks, when killed, control pig was infected.

2.

500 cc. formalin; time, 9½ hours.

Anthrax, with spores,

3	upon cloth	3 sterile	
5	" blanket	5 "	
6	" aluminum	6 "	
3	upon alum'um in 2 layers of cloth	1 sterile	2 not sterile
2	" " " 5 " "		2 " "

Diphtheria,

3	upon cloth	3 sterile	
5	" blanket	5 "	
6	" aluminum	6 "	
2	" " in 2 layers of cloth	2 "	
2	" " " 5 " "	2 "	

Tubercle sputum spread in Petri dishes, and pig inoculated. No infection, sputum sterile.

3.

1,000 cc. formalin; time, 12 hours.

Anthrax,

4	upon aluminum	3 sterile	1 not sterile
5	" cloth	5 "	
5	" blanket	5 "	
6	" alum'um in 2 layers of cloth		6 " "
2	" " " 5 " "		2 " "

Diphtheria,

7 upon aluminum	1 sterile	6 not sterile
2 " " in 2 layers of cloth		2 " "
2 " " " 5 " "		2 " "
5 " blanket	5 "	
4 " cloth	4 "	

4.

500 cc. formalin; time, 11 hours. Swabs of cotton half an inch in diameter that had been rubbed over the membrane in the throat of a diphtheria patient were exposed, and then dropped into tubes of bouillon. All were found sterile.

5.

Room 15,000 cu. ft. space. Two rooms opening into each other. Bits of blanket were rubbed over the surfaces of serum tubes of diphtheria, and then wrapped in two layers of heavy sterilized cotton cloth. These were scattered about the room, 1,500 cc. formalin used, or 100 cc. for every 1,000 cu. ft. Time, 14 hours. None of the cultures were sterile after a week's incubation.

6.

Three rooms opening into each other, containing 7,000 cu. ft. of space. A heavy wind was blowing outside, and the windows were loose, and currents of air could be felt in the rooms; 1,500 cc. of formalin was used. Bits of blanket were soaked in the water from serum culture of diphtheria and anthrax, and part of them wrapped in packets with two layers of cloth, the others exposed free in the different rooms. Time, 10 hours.

3 anthrax, in packets	1 sterile	2 not sterile
3 Klebs-Löffler, in packets	3 "	
6 anthrax, free	2 "	4 " "
6 Klebs-Löffler, free	3 "	3 " "

7.

Same room, 7,000 cu. feet capacity; a quiet day; formalin, 1,500 cc.; time, 11 hours; diphtheria soaked into bits of blanket, free, and in packets.

In room farthest from generator,		
6 upon shelf, free	6 sterile	
7 " stool	7 "	
5 in packets		5 not sterile
In middle room,		
6 upon floor, free	6 sterile	
7 " table	7 "	
8 in packets		8 not sterile
In first room,		
9 upon desk, free	9 sterile	

8.

We were asked to disinfect a schoolhouse, where there had been a case of diphtheria the day before. There were three rooms: Room A contained 12,000 cu. feet, Room B, 12,000, Room C, 3,000. Packets with the Klebs-Löffler bacillus upon bits of blanket, and free in Petri dishes, were placed about the room, the ventilators closed and curtains drawn; 2 litres of formalin were turned into each of the two larger rooms and 500 cc. into the smaller. This was blown in at the rate of 1 litre per hour. The rooms were left closed over night and the test objects gathered in the morning. The fumes were very strong, but the windows were thrown open, and the regular sessions were held without much trouble. Cultures were made from the test objects, and incubated. All the free bits of blanket were sterile, of the packets 5 were not sterile and one sterile. From this series of experiments it was concluded that in some cases it was impossible to sterilize in room disinfection, solid objects, like aluminum upon which the bacteria had been spread in thick layers mixed with albuminous substances, which coagulate under the action of the formalin. This was shown in No. 3, where a litre of formalin was used for 3,000 cu. feet, and some of the aluminum objects gave growths where the others were sterilized. It is also shown very clearly, that, in large rooms or areas, it is impracticable to try to kill virulent germs when covered by one or two layers of cloth, but that those exposed freely, or soaked into the meshes of thick blanket, are readily destroyed, and, finally, that thorough disinfection cannot be

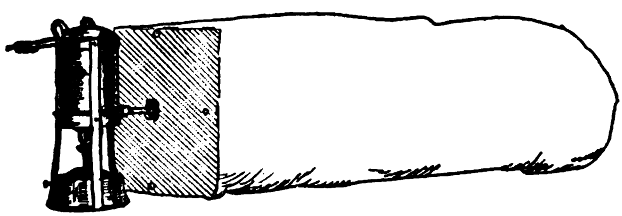
accomplished when there is much wind blowing, especially if the rooms are upon the exposed side of the house, unless precautions are taken to seal both the windows and doors.

SOME EXPERIMENTS WITH PARAFORMALDEHYDE.

A bell jar of 580 cu. in. capacity was placed over a piece of board, through the center of which was a hole large enough to let through the bottom of a small evaporating dish. Under this was placed a small lamp, which vaporized the tablets of paraform, placed in the dish. Inside the jar was a small rack, large enough to hold several wire trays. With this apparatus several experiments were tried, to find out the minimum time of exposure necessary to kill germs in an atmosphere saturated with the aldehyde vapors, and incidentally test the degree of penetration of the dry gas. In the wire trays were spread pieces of cheese cloth, and upon these were placed bits of blanket soaked in diphtheria cultures, still wet. These were covered by another piece of cloth. In one of the trays was placed a clean glass slide. One tablet of the paraform was evaporated, time, 1 hour. All the cultures made from the test objects were sterile. In this experiment the inside of the jar became thickly coated with the greasy paraform, and also the slide between the layers of cheese cloth. In the second trial, there was placed in the evaporating dish, in addition to the tablet, about a spoonful of 95 per cent. alcohol; time, 1 hour; all objects found sterile. There was no coating in the inside of the glass in this case, save a slight moisture from the vapor of the alcohol; the glass slide was damp upon the upper side. In the third trial, one tablet and ½ cc. of alcohol were used; time, ½ hour. All the bits of blanket were sterile, save the three controls, which gave growths. In the fourth trial ¼ of a tablet and 13 drops of alcohol were used; time, 20 minutes. Everything was sterilized. There was not enough alcohol used to prevent the coating of the jar. Fifth trial; ¼ tablet paraform, 1 cc. alcohol; time, 15 minutes; all sterile. A diaphragm of 16 layers of heavy cloth was made, and placed half way up the jar, dividing it into two equal parts. This partition was held in place by a wire hoop, and the edges made tight with melted paraffin, so that the gas would have to pass through all the thicknesses of cloth to get into the

upper chamber. Test objects upon bits of blanket were placed both above and below this partition; ½ tablet of paraform was evaporated, and, after 15 minutes, the test objects were subjected to ammonia fumes, for 15 minutes. All the objects below were sterile. Of those above, 2 were sterile, and one was not. After 20 minutes the first objects were taken out, others were put in; no additional paraform was used; time, 20 minutes, exposed to ammonia 10 minutes. Above the diaphragm, all were sterile, below, 2 were sterile, and 1 was not. Other experiments are underway along this line. There is no doubt but that this will be an excellent method of sterilizing instruments, as bright pieces of steel were suspended in the vapor, and, beyond the moisture from the alcohol, there was no other coating or corroding of the surface. But it is necessary that some other body be vaporized with the paraform, to keep it from repolymerizing and making a disagreeable coating upon free surfaces. A very small amount of alcohol does this very effectively. In this way very short exposures are effective, as in a limited space a very high degree of concentration is obtained. Fifteen minutes was found to be ample time for the sterilization of diphtheria in thick woolen blanket. In work of this kind great care must be taken to neutralize the objects before they are transferred to the bouillon. The rapidity with which the dry gas passed through the thick partition was somewhat surprising. Where no alcohol was used, the part of the jar above the diaphragm was coated nearly as quickly, and as thickly, as the part below; and we have no doubt that the gas has the power to penetrate more than double the layers of cloth used.

FIG. 7.



Disinfecting Bag.

EXPERIMENTS WITH A GAS-TIGHT BAG.*

There has always been a need for some cheap portable apparatus, for the thorough disinfection of bulky articles like clothing and bedding, which would be within the means of every Board of Health of town or city. It has always seemed safest to burn all the bedding and clothing after the more dangerous infectious diseases, in fact, in most instances that has been the only safe method, for to attempt their sterilization, with the ordinary means at the command of the average practitioner, would be entirely useless. In large cities and hospitals, where a large steam disinfecting plant can be commanded, it is a comparatively easy matter. Several portable chambers have been made for the use of formaldehyde, but they all are heavy and bulky, and on that account do not commend themselves for general use. They also entail considerable mechanical skill and expense, for their construction and use. Our idea has been, in all our work upon formaldehyde, to make all apparatus as simple and inexpensive as possible, to bring it within the means of any Board of Health, rather than to multiply expense and profit by complicated and costly appliances. Our first idea was to make a bag of some gas-tight material which would be very light, and could be rolled into very small compass, for transportation from place to place. Into this we intended to conduct the gas from some form of generator and get a much higher degree of concentration than it would be possible to obtain in a larger space. Many experiments were tried with various materials to find something that would answer all the requirements of flexibility and imperviousness. Rubber, the first thing naturally suggested, was out of the question on account of its cost, which, to make the thing successful, must be kept at a very low figure. A large canvas bag was obtained, such as sailors use for their effects upon shipboard, only much larger. This was made of heavy canvas, with the seams carefully sewn, sailor fashion, 8 feet long and 30 inches wide, making a cylinder, when opened, 20 inches in diameter. We found it would be impossible to gather this at the mouth, bag fashion,

* Dr. Wyatt Johnston of Montreal, made experiments with use of gas-tight bags in 1897 (Brit. Med. Jr., Dec. 25, 1897). The authors were not aware of this when their experiments were made.

tightly enough to hold the gas, because of the stiffness of the material. So a square head was made of canvas, stretched over a frame of 1 inch square wood, mitered together, and another frame of equal size was tacked tightly into the mouth of the bag, with a layer of felt between the canvas and the frame, to make it tight. Another layer of felt was placed between the frames, and they were drawn close together by four ¼ inch bolts with thumb nuts. In this way the mouth could be quickly and effectually closed, at very little expense. In the center of the canvas head, two small squares of sheet copper were riveted together, one on each side; through these a small hole was made, large enough to admit the conducting pipe of the Bowdoin vaporizer. After several trials the canvas was found not to be sufficient to hold all the gas blown into it, but, upon wetting it with salt and water, very little escaped into the room. Also, when wrapped in a single layer of cotton cloth, wet in the same solution, the same results were obtained. While this was a very simple way of accomplishing the object, it did not seem very practicable, for we wished to have the bag always ready for use, without having to bother in this way. So, after thoroughly wetting the canvas with salt and water, a thin coat of white lead and oil was put on, and, when this had thoroughly dried, a second one. This treatment made everything thoroughly tight, and no gas could be detected in the room, no matter how much formaldehyde was used. When 4-500 cc. of formaldehyde were driven into the bag at the high temperature given by the Bowdoin vaporizer, the temperature in the limited space rose to 80° or 90° C. This we thought would be an added advantage in efficient disinfection, by increasing the amount of penetration.

No. 1.

In the first experiment in disinfecting with this apparatus, bits of blanket soaked in diphtheria cultures were used, wrapped in two layers of cotton cloth; these in turn were placed in the different things as follows:

2 layers of cotton batting,
5 layers of towel.
Wrapped in coat, and in pockets.
Envelope and paper, sealed.

The ends of the cotton and towel rolls were tied tightly with cord, to prevent free access of the gas between the layers.

300 cc. of formaldehyde and 200 cc. of water were used, and the bag kept closed for 9 hours.

All of the objects were found to be sterile after a week's incubation. The four controls gave heavy growths.

No. 2.

Test objects as before. Both anthrax with spores and diphtheria were used. 200 cc. of formaldehyde; time, 9½ hours.

Anthrax,

1	7 layers towel		sterile	
2	Rolled in cotton batting		"	
3	In envelope and paper	2	"	1 turbid
1	In pillow		"	
1	Rolled in cotton batting comforter		"	

Diphtheria,

1	7 layers towel		sterile	
1	cotton batting		"	
2	letters	1	"	1 turbid
1	pillow		"	
1	comforter		"	
2	controls			"

No. 3.

Diphtheria cultures upon bits of blanket wrapped in two layers cotton cloth. These were pinned upon a heavy cotton wool comforter, and upon several yards of cotton cloth, and then stuffed loosely into the bag. Some were also wrapped in cotton, and other packets left free. 250 cc. of formaldehyde was used. Time, 9 hours. All were found sterile after incubation.

No. 4.

400 cc. of formaldehyde. Time, 10 hours.

2	8 layers of towel	2	turbid
2	several layers cotton batting	2	sterile
5	pinned upon comforter	2	"
1	in letter	1	"

No. 5.

500 cc. formaldehyde. Time, 10 hours.

2	packets in letters	sterile
5	upon comforter	"
4	in rolls of cotton batting	"
2	in 5 layers cotton cloth	"
2	in 7 layers towel	"

No. 7.

500 cc. formaldehyde. Time, 9 hours.

2	packets in 16 layers cotton cloth		sterile	
2	" " letters		"	
9	" upon comforter		"	
2	" in centre of feather pillow		"	
2	" " 6 inch roll cotton	1	"	1 not sterile
2	" " 10 layers cotton cloth	1	"	1 " "
3	" " pockets, woolen coat		"	
2	" " heavy cushion		"	

These experiments demonstrate two things very clearly. In very concentrated amounts, penetration with formaldehyde can be obtained through rather bulky articles, and to a far greater degree than we expected. In properly treated canvas we have a material with which chambers can be cheaply constructed gas-tight, for the use of disinfecting gases. The only objection to the small bag is, that the moisture from the evaporated solution collects upon the inside of the bag, and, where the goods come in contact, some wetting occurs. But in this form all ordinary bedding and clothing could be disinfected without damage. Other forms could be made, and larger, with hooks for hanging up the articles, where it would not take as much of the solution to sterilize as where everything is stuffed closely together within a bag. Other experiments will be continued along these lines with other forms of apparatus, and also to see if steam cannot be used in the same manner.

EXPERIMENTS WITH SULPHUR FUMIGATION.

For a comparative experiment in room disinfection, 12 pounds of roll sulphur were obtained for one of the same rooms used in the aldehyde experiments. This room has a capacity of rather more than 2,000 cu. ft. The sulphur was placed in an iron kettle, and this in a copper tank filled with water so that the water came up around the kettle above the top of the sulphur. The sulphur was wet with alcohol and set on fire, and the room closed tightly as possible. Diphtheria and anthrax cultures soaked into bits of blanket were placed about the room, some free and others in packets. Twelve hours afterwards the sulphur was found still burning, and so the room was left closed for twenty-two hours. In the morning it was impossible to enter the room to collect the cultures until after the windows had been opened for some time. All the windows were covered with a heavy dew of sulphurous acid, and the Petri dishes and cultures in the same way. Two or three litres of water had been evaporated and all the sulphur burned. Every one of the cultures grew luxuriantly after a day's incubation. This result was so decidedly positive that it was thought unnecessary to make further experiments with sulphur. It showed how utterly worthless this agent is, by the side of the formaldehyde disinfection, even when properly used in these large amounts.

SUMMARY OF EXPERIMENTS.

Bouillon cultures or germs suspended in water are much easier killed when spread upon the test objects, than smears made of germs scraped from the solid media. This is due to the fact that, in one case, but a thin layer is deposited over the whole surface, and, in the other, varying thicknesses of albuminous matter must be penetrated, for thorough sterilization. Formaldehyde is also a coagulator of albumens, and we could expect very little penetration in such substances. Solids used for test objects are much harder to disinfect, than pieces of cloth or cotton through which the gas can penetrate. When the test objects are subjected to the fumes of ammonia, after exposure to formaldehyde, more growths are obtained than when they are put into the culture medium at once.

The after cultures should be incubated for at least five days. After that time very few additional ones give growths, if the objects have been neutralized first by the ammonia. All growths should be examined, to avoid the possibility of accidental contamination.

For surface disinfection in the lamps using wood alcohol, at least 2 litres for 3,000 cu. ft. should be used, and the room kept closed for ten or twelve hours. For the forms regenerating from the 40 per cent. solutions, at least 250 cc. for every 1,000 cu. ft., and the room closed for the same length of time. In small rooms under 3,000 cu ft., these amounts will penetrate one or two layers of cloth, and sometimes several. But, in large spaces, no penetration can be depended upon with that proportion. This can be obtained by increasing the amount used. In small enclosed spaces of a few feet in capacity, with large amounts of the aldehyde a marked degree of penetration can be obtained. Surfaces are rendered sterile in very short periods, 10 or 15 minutes, by concentrated amounts in limited spaces.

Damp test objects were as easily sterilized as when dried before exposure, but germs in liquids could not be killed to any depth.

There are places in nearly every room where it is almost impossible to sterilize objects. In working with a disinfectant of this kind one must remember that he is working with a gas that is subject to all the laws of a gas. The currents of air in every room must be taken into account. When the air is warmer inside the room, the currents of air will rise on the side of the room opposite the windows, pass across the ceiling and upon reaching the cold windows suddenly descend to the floor where they pass along to the other side and up again; the colder air rushes also through every crack into the warmer space. So test objects placed upon window ledges or upon the floor beneath the window, or by the cracks under a door are very apt to be found not sterilized. On windy days, in rooms upon the exposed side of the house the gas escapes so rapidly that it is next to impossible to get thorough disinfection.

The range of temperature between 50°-80° seems to make but very little difference to the action of the gas.

The best form of apparatus for using formaldehyde is the one that can be relied upon to put the most gas into the room in its most active form in the shortest time, which combines simplicity, durability and cheapness. If the necessary degree of concentration could be obtained, free surfaces could be disinfected in a very short time. The lamps generating the gas directly from the wood alcohol are fully as effective when they give it off fast enough, as those generating it from the solution. The main idea is to get a certain amount into the room in as short a time as possible. These are the points to be aimed at in the selection of a generator of either kind, many forms of which are now upon the market.

Formaldehyde has been tested as no other disinfectant has ever been, in the different laboratories all over the world, and it is without doubt a safe and trustworthy gaseous disinfectant, if intelligently used.

The authors of this paper hope to try a great many more experiments with it, as time will allow, but they do not believe that any more are necessary to establish its germicidal power or its feasibility. They are certain, also, from what they have seen, that it is as important to have an intelligent user of it, as a good disinfectant. The disinfecting of a house after a contagious disease, has been, in the past, too frequently put into the hands of persons who were only interested to get through with it with the least trouble. They could burn a little sulphur in a house and call it disinfected. They do not care for any new method, especially if it requires more time and no more pay. Such conditions must be changed wherever they exist, if actual disinfection is to keep up with the knowledge of the subject. Men must be employed to do it who realize the importance of it, and know how to correspond their work to the conditions. As long as men did not know what they were fighting, they could only strike out aimlessly into the dark. They could build fires in the streets of a city in order to disinfect it, or hang bags of sulphur about their necks to ward off the plague. Now we know just what the danger is and how it should be met, and there is no excuse for not meeting it properly.

BOWDOIN COLLEGE,
Brunswick, Maine.

January 10, 1898.

NOTES ON DISINFECTANTS AND DISINFECTION.

By A. G. YOUNG, M. D., Secretary of the Board.

PREFATORY.

In the following "Notes" the aim has been to present a review of the experimental work which has been done, more particularly in recent years, for the purpose of determining the germicidal value of the various agents which have been in use, or have been suggested as disinfectants. Incidentally their antiseptic and deodorant qualities receive some attention.

In addition to the bare results obtained by each worker, or the conclusions which he draws, a few words in regard to his methods, or the conditions under which his experiments were done, are given for some of the more important pieces of work. In the references to the literature consulted, the year of publication as well as the volume and page is given, because it is worth something to him who would look up the original paper to know whether the work is, or is not, recent. As a general rule the more recent the work, the more trustworthy the results.

A logical arrangement of a work of this kind would be into disinfectants and the practical application of disinfecting agents to special purposes. As a convenience in reference, however, everything is brought under one alphabetical arrangement.

The amount of valuable work which has been done since the publication of Koch's remarkable paper in 1881, and the report of the Committee of the American Public Health Association a few years later, has truly been enormous, nevertheless, these notes show very conclusively that an immense amount of work is still required to determine unsettled points relating to the value of even the best known disinfecting agents, or their applicability to various purposes. The casual reader of the results which have already been obtained is, perhaps, confused by discrepancies. The careful student of literature of this kind

may, however, learn to estimate the approximate value of the work of various investigators, and of each succeeding series of years. Some of the reasons why the results obtained by different persons have not been more nearly uniform are these:

1. The test-bacteria used by different investigators have not been the same. The vital resistance of the various species is very diverse. The results obtained in testing disinfectants on the spirillum of cholera or the bacillus of plague give but little information relative to the value of the same disinfectants when used for the destruction of the infection of diphtheria or of tuberculosis. A fault of many of the older experiments is that test-organisms were used which are of but little interest to the practical health officer. The practical value of the later experiments is greater because they have more generally dealt with the infection of typhoid fever, diphtheria, tuberculosis, and Staphylococcus pyogenes aureus,—species of bacteria with which most of the work of disinfection has to do.

2. The power of resistance of the same species of bacterium varies greatly under different conditions, or when their source is different. For instance, Baer found that a freshly inoculated culture of the bacillus of diphtheria was destroyed with 1:5000 of nitrate of silver, but that a 24-hour culture required 1:1000 of the same agent to sterilize it in the same space of time. In some work done by Esmarch he made use of anthrax spores from seventeen different sources. They were destroyed by steam at 212° F. in from one to twelve minutes, and by a 5 per cent. solution of carbolic acid in from two to forty-two days.

3. The media in which the test bacteria exist influence strongly the action of disinfectants. The bacillus of tuberculosis dried upon threads or in aqueous suspension may be destroyed by mercuric chloride, but in fresh tuberculous sputum, it cannot be trusted to sterilize it. As illustrative of the influence of media, Behring says that sporeless anthrax bacilli in water are killed by corrosive sublimate, 1:500,000; in bouillon, by 1:40,000; but in blood serum not with certainty by 1:2000. Some disinfectants are influenced very much by the character of the material which contains the infectious germs, while other disinfectants are influenced in a comparatively slight degree. The experimental work which does not take the influence of media into account is not of much value, and frequent failures are to

be expected in the work of the disinfector who does not bear the same thing in mind.

4. The temperature under which a disinfecting agent acts influences very much the rapidity and the certainty of its action. Thus, in Heider's experience, anthrax spores that survived the action of a 5 per cent. solution of carbolic acid thirty-six days at ordinary room temperature, were killed in from one to two hours at 131° F., and in three minutes at 167° F. Some investigators have failed to state the temperature under which their disinfectants acted.

5. In many of the experiments, the inhibitory action of the agent in question has been mistaken for its germicide action. After the bacteria have been subjected to the influence of a disinfectant for a given time, though not killed, their vegetating and pathogenic capabilities may be weakened. When, in this condition, they are transferred to fresh culture media a minute trace of the disinfecting agent suffices to retard growth for some time or indefinitely. The precautions against the transference of a trace of the disinfectant which were observed only a few years ago, do not correspond with the requirements of the present day. To Geppert[1] belongs the credit of bringing this fact prominently into view. In most of the later work the necessity of a comparatively long period of observation for the cultures is recognized, a precaution which was not sufficiently observed in much of the earlier work.

6. In other respects than those which have been mentioned, the methods pursued by investigators have differed. In many works the description of the methods followed are not sufficiently explicit to enable one to judge of the trustworthiness of the results or conclusions.

ACIDS.

Among the acids that, when sufficiently concentrated, are capable of destroying spores, Behring[2] classes hydrochloric, nitric, and sulphuric. Diluted with water the minimum proportion of these acids which prevents the growth of the anthrax bacillus is 1:555, 1:384, and 1:400 respectively. Hydrochloric acid is, according to Behring, more antiseptic than either of

1. See Mercuric Chloride.
2. Bekampfung der Infectionskrankheiten, II., 86. 1894.

these other acids. Koch[1] found that 2 per cent. of hydrochloric proved deadly to anthrax spores in ten days, and that a 1 per cent. dilution of sulphuric acid did not kill, but only retarded their growth.

In the experiments of Uffelmann[2] sulphuric acid and water in equal parts destroyed with certainty all germs in fecal matter in two hours, and a mixture of acid, one part, and water, two parts, destroyed them in six hours. Hydrochloric acid and water, equal parts of each, sterilized in twelve hours; but one part of acid with two parts of water, did not destroy all germs with certainty in twelve hours, but did in twenty-four hours.

In Baer's[3] experiments, the tests were made by adding the acids to bouillon cultures. With hydrochloric acid, sporeless anthrax cultures were sterilized in two hours with from 1:1600 to 1:1100 of the acid; diphtheria with from 1:1600 to 1:700; glanders in from 1:300 to 1:200; typhoid in from 1:900 to 1:300; cholera in from 1:1850 to 1:1350. The first proportions were with fresh cultures, the second with 24-hour cultures.

With sulphuric acid sporeless anthrax cultures were sterilized in two hours with from 1:1700 to 1:1300; diphtheria with from 1:1200 to 1:500; glanders with 1:250 to 1:200; typhoid with 1:500; cholera with from 1:1800 to 1:1300.

The irritating and corroding action of the acids reduces the antiseptic and disinfectant adaptability to a very narrow sphere. Their addition to solutions of carbolic acid and of corrosive sublimate are mentioned under the appropriate headings.

ALCOHOL.

The experiments to determine the disinfectant and antiseptic value of alcohol, and the conditions under which its use is, or is not, successful, have given rise to diverse conclusions. In the experiments of Sternberg[4] 95 per cent. alcohol did not destroy the bacteria (spores) in broken down beef tea in forty-eight hours. Micrococcus Pasteuri was destroyed by two hours' exposure in a 24 per cent. solution; pus cocci required a 40 per

1. Mittheil. a. d. Kais. Ges., I., 268. 1881.
2. Berliner Klin. Woch.—Centr. für Bak., XII., 233. 1892.
3. Zeit. für Hygiene, IX., 482. 1890.
4. Manual of Bacteriology, p. 189. 1892.

cent. solution. Koch[1] subjected anthrax spores to absolute alcohol, to 50 per cent. alcohol, and to 33 per cent. alcohol one hundred and ten days without the destruction of them. He found, however, that the growth of the anthrax bacilli without spores was hindered by 1 per cent. of alcohol and ceased when the mixture of alcohol was 1:12.5 of water.

Schill and Fischer[2] found that tubercle bacilli in fresh tubercular sputum were destroyed in twenty hours with absolute alcohol. Their experiments indicated to them that more than five parts of alcohol to one of the material to be disinfected is required, and that the cost is prohibitive of disinfection with this agent. "Yersin found that in pure cultures the tubercle bacillus is killed by five minutes' exposure to the action of absolute alcohol."[3]

As an auxiliary in the disinfection of the hands, Reinicke[4] claimed that beside its solvent action upon the oily matter in the skin, it has a true germicide action. In an extended series of investigations, Ahlfeld[5] confirmed the opinion of Reinicke that alcohol under favorable conditions is an active disinfectant. A second series of experiments of Ahlfeld and Vahle[6] shows quite conclusively that the most important condition favoring the action of alcohol is that the bacteria subjected to it shall contain water,—that is, that the material to be disinfected must previously be moistened. Thus used, they found alcohol to be a rapid and efficient disinfectant for the hands without the use of further disinfectants as in the Fürbringer method.

In Epstein's[7] experiments in the disinfection of the hands with alcohol, he used infected threads carefully protected at all stages of the experiments not only from the action of direct light, but also from that of diffused light. The micro-organisms used as test bacteria were pyocyaneus, prodigiosus, and Staphylococcus pyogenes aureus. His experiments show that as the strength of alcohol is diluted down to 50 per cent., its disinfecting power increases, but that there is a diminution of this power as the dilution is carried below fifty per cent.

1. Mittheil. aus dem Kais. Gesund., I., 263 and 278. 1881.
2. Mittheil. aus dem Kais. Gesund., II., 131. 1884.
3. Quoted from Sternberg.
4. Centr. für Gynakol.—Centr. für Bak., XXII., 916. 1895.
5. Deutsche Med. Woch., XXI., 851. 1895.
6. Deutsche Med. Woch., XXII., 81. 1896.
7. Zeit. für Hygiene, XXIV., 1. 1897.

His experiments include, also, the determination of the action of alcoholic solutions of various disinfectants. He tested sublimate 1:1000; carbolic acid, 3 per cent.; lysol, 1 per cent.; and thymol, 0.5 per cent. An examination of all of his tables shows that solutions of these disinfectants in 50 per cent. spirit gave uniformly better results than when they were dissolved in water or in stronger or weaker alcohol. His tables also show that absolute alcohol and solutions of these disinfectants in absolute alcohol are almost entirely without disinfectant power. Their action is a little better, but is still very weak in 80 per cent. alcohol.

As to the action of thymol, his tables show that in the low dilution of 1 part of thymol in 1100 parts of 50 per cent. alcohol, it still has a disinfective power distinctly greater than that of 50 per cent. alcohol alone; this action, however, is not so great as that of a 0.5 per cent. thymol solution.

An advantage of alcoholic solutions of these disinfectants is that they penetrate more rapidly objects to be disinfected, thus removing oil.

For the practical determination of the action of these alcoholic solutions, Epstein made the following solutions: Sublimate, 1:1000; carbolic acid, 3 per cent.; and lysol, 1 per cent. The hands to be disinfected were rubbed with a pledget of cotton batting saturated with a bouillon culture of the bacteria to be used. The bacteria were carefully rubbed into the spaces beneath and around the nails and into all the folds of the skin. Without preliminary washing of the hands, they were scrubbed with a brush and the disinfecting solution to be tested. Then, after the hands had been carefully washed with a large quantity of sterilized water, bouillon cultures were inoculated with the scrapings from beneath the nails, made with pieces of sterilized wood.

As Epstein's intention was to compare his results with those of previous workers, he did not treat the hands with ammonium sulphide after corrosive sublimate solution was used.

An examination of the tables given by Epstein indicate that, in the practical disinfection of the hands, the solution in 50 per cent. alcohol gave the best results.

His conclusions are as follows: That absolute alcohol has no disinfecting power; that 50 per cent. alcohol disinfects better than higher or lower concentrations; that antiseptics which have more or less efficiency as aqueous solutions lose their disinfecting properties when dissolved in high grade alcohol, but that, on the other hand, solutions of sublimate, carbolic acid, lysol, and thymol have a higher power of disinfection in 50 per cent. alcohol than solutions of the same concentrations in water have.

Lenti's[1] experiments were for the purpose of learning the influence of alcohol upon solutions of disinfecting agents. The test-organisms used were anthrax spores. These spores were unaffected by a solution of 4 parts of corrosive sublimate in 1000 of absolute alcohol. A 10 per cent. solution of carbolic acid in absolute alcohol did not affect them. A 1:1000 solution of corrosive sublimate in alcohol containing 2 per cent. of water destroyed the spores in twenty-four hours. A 10 per cent. solution of carbolic acid in 30 per cent. alcohol caused the destruction of the spores in forty-eight hours.

ALKALIES—POTASH AND SODA.

Von Lingelsheim under the direction of Behring[2] determined carefully the degree of acidity and of alkalinity required to inhibit the growth of anthrax bacilli and the quantity of each acid or alkali required to produce this effect. Of the alkalies only the hydrates are rated as destructive of spores at ordinary temperatures. A 30 per cent. solution of caustic soda destroyed anthrax spores in ten minutes, and a 4 per cent. solution in forty-five minutes.

As to the action of alkaline carbonates, we are told that solutions of them are efficient disinfectants when used at higher temperatures than ordinary. With a 1.4 per cent. solution of washing soda at the temperature of 85° C. (185° F.) Behring destroyed anthrax spores in from four to ten minutes, and with the solution at 75° (167° F.) the spores were killed in twenty minutes.

1. Annali dell' Ist. d'Ig. Sper. dell' Un. di Roma, III. (Nuova Serie)., 515. 1893.
2. Bekampfung der Infectinskrankheiten, II., 85. 1894.

Heider,[1] in testing washing soda on anthrax spores, was not so successful as Behring. With him a 2 per cent. solution at 75° destroyed anthrax spores only after two hours.

In Uffelmann's[2] experiments, potash lye of 35 per cent. mixed half and half with water destroyed all germs with certainty in six hours. In the same series of experiments, a 5 per cent. solution of carbolic acid killed nearly all germs in twenty-four hours.

Basing his judgment upon his own investigations, Gerloczy[3] pronounces the lye of wood ashes a very efficient disinfectant of fecal matter. While recommending sulphate of copper highly for this purpose, he says that, "a still more efficient method for the rapid disinfection of stools in the sick-room is pouring over them three times their bulk of hot lye (one part of ashes to two of water)."

Jaeger[4] destroyed readily anthrax bacilli, and the bacteria of chicken cholera and of erysipelas of swine with a 1 per cent. solution of potash or soda, but the bacteria of hog cholera and of glanders and Micrococcus tetragenus were not so easily destroyed. He could notice no difference between potash and soda.

Comparative tests made by Vincent[5] indicated that caustic soda is more efficient than caustic potash. All of his experiments show that the disinfecting value of soda is always a little superior to that of potash; for certain microbes this difference is considerable. For instance, the bacillus of typhoid fever in cultures was killed in less than two minutes by 1:200 of caustic soda, while 1:100 of caustic potash does not always destroy the bacillus in thirty minutes. The typhoid bacillus in stools requires 9 or 10 grams per 1000 to destroy them in twenty-four hours, and the cholera bacillus takes 6 per 1000 to effect its destruction in the same time.

For the disinfection of the bacillus of plague, Giaxa and Gosio[6] found that a 5 per cent. solution of caustic potash at 60° C. (140° F.) suffices with twenty minutes' exposure.

1. Arch. für Hygiene, XV., 341. 1892.
2. Berliner Klin. Woch.—Centr. f. Bak., XII., 233. 1892.
3. Deutsche Viert. f. öff. Ges., XXI., 433. 1889.
4. Arbeiten a. d. Kais. Ges., V., 247. 1889.
5. Annales de l'Inst. Past., IX., 21. 1895.
6. Annali d'Igiene Sperim., VII., 261. 1896.

The disinfecting power of lime and of potash or soda lye are equal when they are of the same degree of alkalinity, we are told by Behring.[1] He further states that neutral calcium chloride and barium chloride are much more powerful disinfectants than potassium chloride or sodium chloride. The disinfecting power of lithium chloride is eight times, and that of barium chloride four times that of calcium chloride.

AMMONIA.

In Behring's table showing the minimum antiseptic strength of various acids and alkalies, it is shown that a 1:417 solution of caustic ammonia inhibits the growth of anthrax bacilli, and that 1:50 of ammonium carbonate has the same effect.

In a paper "On the Antiseptic Property of Ammonia," Gottbrecht[2] showed that both ammonia and carbonate of ammonia have well marked antiseptic powers. Specimens of animal tissue were shown in a very perfect state of preservation after they had been kept many months in from 5 to 8 per cent. solutions of Liquor ammonii caustici or in hermetically closed jars in which a piece of ammonium carbonate had been placed.

In experiments with the object of determining the suitability of ammonia gas for the disinfection of rooms, Rigler[3] poured aqua ammonia into large shallow vessels from which the gas evaporated. The room in which the experiments were made had a capacity of 99.8 cubic metres. The doors and windows were tightly closed. The test-bacteria were on linen threads free or packed. When packed, either in dry or damp cloths, the bacilli were enveloped in eight thicknesses of sterilized cloth. The temperature of the room was from 18° to 20° C.

Cholera bacillus.—The threads enveloped in dry cloths were sterilized in three hours. In damp cloths, the time required for sterilization was four hours. Cholera threads, uncovered, were sterilized in two hours; but the controls in pure air were also sterile in three hours.

Typhoid bacillus.—Free threads were sterilized in two hours; in dry cloths, in two hours; in damp cloths, in six hours.

1. Zeit. für Hygiene, XXV., 413. 1897.
2. Deutsche Med. Woch., XIV., 601. 1888.
3. Centr. für Bak., XIII., 651. 1893.

Anthrax bacillus.—On threads lying free, and on those in dry cloths were destroyed in three hours; on those in damp cloths, in five hours.

Anthrax spores.—On threads open and packed in dry cloths, were destroyed in three hours (!) ; on threads in damp cloths, in eight hours.

Diphtheria bacillus.—They were destroyed in four hours whether lying free, packed in dry cloths, or packed in wet cloths.

Each of these separate experiments was repeated several times. With all these, control experiments were carried on, and in every case innumerable bacilli were present in twenty-four hours. After the shallow vessels were filled, the ammonia gas was given off at the following rates: 200 grams of the liquor ammonia in 1 hour; 250 in 2 hours; 300 in 3 hours; 350 in 4 hours; 390 in 6 hours; and 450 in 8 hours.

Rigler concludes that the vapor of ammonia has a very strong disinfecting action on the most important pathogenic bacteria. He advises the use of ammonia vapor in the disinfection of rooms, articles of clothing, and furniture in connection with cholera, typhoid fever, diphtheria, etc. One recommendation of this agent is its small cost and the absence of danger in the use of it. Further than this we are told that the furniture and fabrics in the room were in no wise injured or discolored. One kilogram is required for the disinfection of each 100 cubic metres of space to be disinfected. The aqua ammonia should be poured into large and shallow vessels, and the rooms should remain closed eight or ten hours.

Under the direction of Bordoni-Uffreduzzi, Moreno[1] carried out a series of experiments in the laboratory of the University of Torino for the purpose of confirming or disproving the correctness of Rigler's conclusions. The results obtained in Torino, even with a much greater concentration of the vapor, are just the opposite of those in Budapest, and the conclusion is that "the vapor of ammonia is a very illusory and inefficient means of disinfection. It is distinctly less active than chlorine, bromine, iodine, or sulphurous acid gas, all of which disinfectants have been given up, for one reason or another; and ammonia merits no better fortune."

1. La Riforma Medica, III., 160. 1894.

ANILIN DYES (PYOCTANIN).

Dr. Stilling's opinion of anilin as a local antiseptic, as translated by Dr. Stevenson,[1] is that the local application of a 1:1000 solution of methyl violet does not cause irritation. He says that in treating hundreds of patients with it, this has invariably been his experience. He has also found its use in surgical practice quite free from toxic symptoms. The irritating effects observed by some investigators and practitioners, he believes due to impurities such as chlorid of zinc, arsenic, and copper sulphate.

The results of his experiments indicate that methyl violet is about three times as strong as sublimate in its action on the anthrax bacillus, and quite as effectual as sublimate in its action on Staphylococcus pyogenes aureus; that it is a perfectly non-poisonous substance; that, in consequence of this, it is immaterial how strong the solutions may be, even up to the use of the pure substance itself; that it does not coagulate albumen; and that it possesses an extraordinary power of diffusion, penetrating into the eye like atropin. He has found it very efficient as a local application for various diseases of the eye. In conclusion, he calls the attention to the necessity that these anilin dyes be absolutely pure.

As a topical remedy in diseases of the eye, he prefers, in many cases, auramin (yellow pyoctanin) as being more soothing and giving less noticeable stains.

The favorable report of Stilling led many others to test for themselves the antiseptic value of the anilin colors. Petersen,[2] of St. Petersburg, used it in many cases both in hospital and private practice, with excellent results. Fessler,[3] of Munich, found it to be a very efficient antiseptic in the surgical clinic of the University, used as a 1:1000 solution and as a gauze. Bacteriological experiments confirmed his conclusions as to its bactericide value. Garre and Troje,[4] however, report less certain clinical and antiseptic results.

At the Tenth International Medical Congress, Valude,[5] of Paris, stated that he had found that the anilin colors which

1. The Lancet, I., 1891. 872.
2. St. P. Med. Woch.—Centr. für Bak., IX., 134. 1891.
3. Münchener Med. Woch.—Centr. für Bak., IX., 135. 1891.
4. Ibid.
5. Centr. für Bak., IX., 711. 1891.

are called "Pyoctanin," are only feebly antiseptic, yet their power of penetration recommends them as superior to mercuric chlorid in some cases.

Of the anilin dyes, malachite green is, according to Behring,[1] the most effective, anthrax and cholera bacilli being destroyed with 1:25,000; diphtheria bacilli with 1:8000; and glanders and typhoid bacillus with 1:300.

In bouillon, Baer[2] found that methyl violet restrained the growth of sporeless anthrax bacilli in the proportion of 1:70,000; diphtheria, 1:10,000; glanders and typhoid fever, 1:2500; cholera, 1:30,000. The quantity required to destroy in two hours, bacteria in 24-hour cultures in bouillon was: anthrax bacilli, 1:5000; diphtheria, 1:2000; glanders and typhoid fever, 1:150; cholera, 1:1000.

With malachite green, the same experimenter learned that in bouillon the growth of sporeless anthrax bacilli was restrained with 1:120,000; diphtheria with 1:40,000; glanders and typhoid fever, 1:5000; cholera, 1:100,000. The quantity required to destroy in two hours bacteria in 24-hour cultures in bouillon was: anthrax bacilli, 1:40,000; diphtheria, 1:8000; glanders and typhoid fever, 1:300; cholera, 1:5000. Baer's results, therefore, confirm those of Behring in showing that malachite green is more actively germicidal than methyl violet.

ANYTIN AND ANYTOLS.

Anytin when dry is in the form of a brownish-black, exceedingly hygroscopic powder which is soluble in water, giving clear solutions in all proportions. It is a coal-tar derivative. Its solutions in water have the remarkable property of rendering easily soluble, phenols, cresols, essential oils, the camphors, iodine, etc., which are but slightly soluble in water.

These agents when brought into solution by the aid of anytin are called anytols.

Loeffler[3] gives the results of a series of investigations which have been carried on in the Hygienic Institute of the University of Greifswald to determine the germicidal properties of anytin

1. Zeit. für Hyg., IX., 424. 1890.
2. Zeit. für Hygiene, IX., 482. 1890.
3. Deutsche Med. Woch., XXIV., 149. 1898.

and anytols. He used as test-organisms B. diphtheriæ, B. anthracis, Streptococcus pyogenes, B. mucosus ozaenae, B. typhi, Staphylococcus pyogenes aureus, B. pyocyaneus, and B. cholera Asiaticae.

The tables which are presented indicate that the anytols are distinctly more efficient as germicides than simple aqueous solutions of the respective disinfecting agents. Thus a ½ per cent. solution of cresol-anytol acts as vigorously as a 1 per cent. cresol solution, and is as efficient as a 2 per cent. solution of carbolic acid. Solutions of anytin alone have a distinct germicide action. The tables further show a marked difference in the action of anytin and the anytols upon different organisms. While the bacillus of diphtheria and of anthrax and Streptococcus pyogenes were readily destroyed, the anytols were less efficient when applied to the other bacteria. Albuminous matters did not interfere with the antiseptic action of the anytols.

Loeffler shows that a 1 per cent. meta-cresol-anytol solution is about equal to a 3 per cent. carbolic acid solution, and he finds that the 3 per cent. cresol-anytol solution has a strong disinfecting power, a momentary exposure sufficing to destroy all of the bacteria.

Experiments were also made with stronger solutions of the anytols. A 5 per cent. cresol-anytol solution was tested upon anthrax spores which had an extraordinary resistance. These anthrax spores were destroyed in forty hours by the cresol-anytol solution, while, after they had been exposed to a 5 per cent. carbolic acid solution sixty hours, vigorous growths were obtained. A 10 per cent. cresol-anytol solution was not more effective than the 5 per cent.

The 3 per cent. cresol-anytol solution is recommended for the disinfection of the hands. It affects the skin but very little. Hands were thoroughly rubbed with the culture of staphylococcus in bouillon, then, after Fürbringer's method, brushed with soap and warm water one minute; washed one minute with alcohol; immersed in a 1 or a 3 per cent. cresol-anytol solution for one minute, and finally rinsed with sterilized water. Even when the 1 per cent. solution was used, the hands were rendered sterile so far as streptococci are concerned, though a few colonies of sporing bacilli were present even after the use of the 3 per cent. solution.

Another series of experiments indicate that cresol-anytol solutions are very effective for the local treatment of diphtheria. These solutions, not only are very efficient in the destruction of diphtheria bacilli, but his experiments indicate that they also have the power of neutralizing diphtheria toxin.

BEDDING.

Where facilities for steam disinfection are absent, the efficient disinfection of bedding is somewhat difficult. When a steam disinfector is available, mattresses, quilts, comforters, blankets, and pillows should be treated in it. In the absence of a steam disinfecting apparatus of ample size to receive mattresses, the work may be done as follows:

Mattresses.—If the room is disinfected with formaldehyde gas, leave them in their places entirely uncovered. If formaldehyde is not used, spray or wash thoroughly the entire surface of the mattress with a solution of corrosive sublimate 1:1000; or lysol, 4 per cent.; or carbolic acid, 5 per cent.; or formalin, 5 per cent.

In cases of scarlet fever, diphtheria, or pulmonary tuberculosis, it may be assumed as probable that the infection is only upon the surface. In many cases of typhoid fever, however, when the mattress has been soiled with the discharges of the patient, the only safe assumption is that the infection has penetrated the interior, and in these cases the methods of treatment which insure the efficient disinfection of the interior of the mattresses are absolutely required.

The experiments of Prof. Robinson with a gas-tight bag suggest the probability that the interior of mattresses may be sterilized by enclosing them in impermeable coverings and injecting formaldehyde into their interiors directly, or indirectly by ripping the mattresses.

Mattresses of but little value should be burned when the facilities for their sure disinfection are not available.

Straw Beds, Feather Beds, etc.—The contents of straw beds should be burned, their ticks may then be treated as for clothing.

Feather beds, pillows, quilts, comforters, and blankets should be disinfected with steam. If nothing better is available, extemporized apparatus may be used for this purpose.

Treatment with concentrated doses of formaldehyde may suffice, but exposure in ordinary room disinfection will not.

BENZINE.

As the action of benzine upon disease germs,—when used in the cleansing of infected clothing, for instance,—had been under discussion, Chassevant and Got[1] tested commercial benzine upon anthrax bacilli and Bacterium coli commune. They found that, prolonging the action of benzine from one half to twenty-four hours and then subjecting the goods to a temperature of 70° for another twenty-four hours, bacteria were never destroyed.

BOILING.

All disease germs with which the health officer has to do may be killed by boiling, and most of them are killed in a few minutes by the action of hot water at a temperature considerably lower than the boiling point. Thus Sternberg[2] found that the cholera spirillum was destroyed at the temperature of 125.6° F. in four minutes; typhoid bacillus at 138.8° in ten minutes; bacillus of pneumonia at 132.8° in ten minutes; Staphylococcus pyogenes aureus at 136.4° in ten minutes.

The first committee on disinfection of the American Public Health Association prescribed boiling in water for half an hour for the destruction of spore-containing infectious material, and boiling in water for ten minutes for the disinfection of infectious material which owes its infecting power to the presence of sporeless micro-organisms only.[3]

Comparing boiling water and steam, Krieger[4] states the advantages of the former as follows:

In boiling water bacteria absorb water, are softened and thus their vitality is almost instantly destroyed. In the disinfection with steam it is otherwise; the opportunity is not so favorable for the preliminary maceration and softening. Further, the same volume of steam contains 1700 times fewer molecules of

1. Comptes Rend. Hebd. Soc. de Biol. (Dixieme Serie), III., 473. 1896.
2. Manual of Bacteriology, p. 147. 1892.
3. Disinfection and Disinfectants, p. 233. 1888. Concord.
4. Archiv für öff. Gesund. in Elsass-Lothringen, XV, 9. 1893.

water. Therefore, a longer time is required for the bacteria to absorb a sufficient quantity of water to cause them to swell and soften.

Another obstacle which steam encounters in penetrating bacteria is due undoubtedly to a coating or layer of minute air-bubbles adherent to the germs.

Plunged in water, air-bubbles have a tendency to rise to the surface. This is due to the great difference in the specific gravity of air and water. A difference at the temperature of 100° C. of about 1 to 1,000. In steam disinfection this great help in getting rid of the air is not present. The specific gravity of steam and of air at 100° C. is about as 3 to 5.

BOOKS.

The disinfection of books without injuring them has been difficult. Unbound books may be disinfected with steam with but little harm to them. Bindings are, however, spoiled by steam. The only feasible way of disinfecting bound books appears to be with formaldehyde. If the books are placed on edge, suspended with their leaves opened, or otherwise arranged in a gas-tight casket or disinfecting box so that their leaves will be separated as much as possible, they may be sterilized with formaldehyde in rather concentrated doses.

The fact that the bacteria of some of the most prevalent and dangerous infectious diseases are capable of retaining their vitality for a considerable period of time after they are dried, evinces the danger in books that have been used by infectious persons. According to Flügge,[1] the bacillus of diphtheria in false membrane remains alive three or four months after drying. Abel[2] found that diphtheria infection on toys remained virulent six months. Eyff[3] had typhoid bacilli viable three months after drying on books, and tubercle bacilli from six to nine months. Bordoni-Uffreduzzi[4] found that the diplococcus of pneumonia, in dried sputum, remained alive a long time.

Du Cazal and Catrin[5] examined an old book that had been used in the hospital for a long time. Bacteria cultivated from

1. Zeit. für Hygiene, XVII., 405. 1894.
2. Centr. für Bak., XIV., 756. 1893.
3. Zeit. für Hygiene, XXI., 181. 1896.
4. Centr. für Bak., X., 305. 1891.
5. Annales de l'Inst Past., IX., 865. 1896.

pieces of the leaves were fatal to guinea-pigs. Staphylococci were present. The corners of the leaves furnished more colonies than other parts of the pages. The leaves of new books were soiled with streptococcus pus, pneumonia sputum, diphtheria membrane, typhoid feces, and tuberculous sputum. The leaves were then dried and cultures in bouillon were made from portions of them. Guinea-pigs were inoculated with a drop or two. Positive results were obtained with streptococcus, pneumococcus, and diphtheria. On the other hand, the animals inoculated with typhoid and tuberculosis survived.

The books used in the former experiments were subjected to disinfection forty-eight hours with formaldehyde. All of the leaves were sterilized except those which had been soiled with typhoid feces. After old hospital books had been submitted to the action of steam they were found to be thoroughly disinfected. The leaves were not injured, but the bindings were badly spoiled.

One of the English sanitary journals[1] announced, some time ago, that a new disinfecting apparatus for books had been established at the Central Free Library, Sheffield. The principal upon which the disinfection is based is the vaporization of carbolic acid by heat which, as it is claimed, makes carbolic acid more potent and active. It is stated that the carbolic acid can be vaporized at 80° F., and that at 100° the carbolic acid will be active and will purify the books. The degree of heat used, however, is from 150° to 200° F. dry heat, and the books are subjected to this process for a quarter of an hour. Letters of protection were taken out.

As of interest in this connection, it may be mentioned, upon the authority of a German journal,[2] that all the letters which are written in the Asylums Board Hospital at Kent, England, are subjected to disinfection with steam before they are sent out. In 1884, there were about 1000 cases of small-pox, and postal officials complained that their employes often contracted small-pox. Since the disinfection of letters began, no complaints of this kind have been received. As the letters remain uninjured, the suggestion is made that this process would be suitable for

1. Sanitary Record, IX., 369. 1888.
2. Zeit. für Schulgesund., VII., 105. 1894.

the disinfection of school books that have been in the hands of infectious pupils.

Dr. Schab,[1] in the Institute of Infectious Disease, of Berlin, investigated the value of the so-called *pictet* gas mixture for the disinfection of books. This consists of a mixture in equal parts of sulphurous acid and of carbonic acid gases.

As test objects he used pyocyaneus, staphylococcus aureus, and anthrax spores. In addition tubercle bacilli from tuberculous sputum were used. The experiments did not give satisfactory results, and he found that this process for the disinfection of books is untrustworthy. (See Formaldehyde-*Books.*)

BORIC ACID.

Koch's[2] experiments indicated that boric acid has some antiseptic action. A 1 : 1250 solution retarded the growth of anthrax bacilli. In Sternberg's experiments a saturated solution failed to kill pus cocci in two hours.[3] As applied to Staphylococcus pyogenes aureus on threads, Pane[4] found that a 5 per cent. solution has no effect at 15° C.; and at the temperature of 37° C. (98.6° F.) it has no effect except to retard slightly the development of the bacteria. Rideal[5] says that boric acid is in no sense a disinfectant, and its antiseptic powers are low.

BROMIN.

A few experiments of Koch's indicate that bromin gas is somewhat more active than chlorin. The conditions of the experiments, however, were not like those in practical disinfection. Fischer and Proskauer[6] preferred chlorin because the same disinfecting effect can be had at a lower cost than with bromin, and for the further reason that bromin is still more destructive than chlorin of the goods subjected to their action. The disagreeable and dangerous character of liquid bromin renders it unsuitable for placing in the hands of the public.

1. Centralb. für Bak., XXI., 141. 1897.
2. Mittheil. aus dem Kais. Ges. I., 271. 1881.
3. Manual of Bacteriology, p. 174. 1892.
4. Annali dell' Istituto D'Ig. Sp. dell' Univ. di Roma, II., 78. 1890.
5. Disinfection and Disinfectants, p. 99. 1895. London.
6. Mittheil. a. d. Kais. Ges., II., 307. 1884.

CALCIUM CRESYLATE.

This is recommended by Professor Foder as a disinfectant. It is prepared by slaking 1 part of caustic lime with 4 parts of water and adding 5 parts of crude cresylic acid (cresol). The result is a syrupy fluid, said to be miscible with water in every proportion. "It is cheaper than crystallized carbolic acid, and superior in every way as a disinfectant."[1]

CARBOLIC ACID.

As a disinfectant for material containing spores, Koch[2] determined that carbolic acid is hardly suitable; for the destruction of anthrax spores, a 3 per cent. solution must act seven days, and a 5 per cent. solution requires two days. For sporeless anthrax bacilli, however, he found that a 1 or 2 per cent. solution sufficed to destroy them in a few minutes.

In liquids free from albuminoids, carbolic acid is about one hundred times weaker in disinfecting power than corrosive sublimate, yet in many respects carbolic acid has advantages over the other disinfectant. Its action is uninfluenced by the presence of acids, alkalies, salts or albumen. Behring[3] is also authority for the statement that a 0.5 per cent. solution of carbolic acid destroys, in a few hours, the anthrax bacillus without spores, the bacillus of typhoid fever, of diphtheria, and of glanders, the spirillum of cholera, and streptococci. All of these are killed in one minute with a 1 to 1.5 per cent. solution. Staphylococci require a strength of from 2 to 3 per cent.

The experiments of Sternberg and Bolton[4] fixed a 1 per cent. solution of carbolic acid as near the germicide potency of carbolic acid for pathogenic bacteria generally which are sporeless. Even when the bouillon subjected to the action of carbolic acid contained 10 per cent. of dried egg albumen the results were the same. Elsewhere Dr. Sternberg sums up the value of carbolic acid as follows:

"Carbolic acid, in the absence of spores, is a most effective disinfecting agent, and we have put it seventh in the list below

1. American Analyst, IX., 98. 1893.
2. Mittheil. a. d. Kais. Gesund. I., 241, 243. 1881.
3. Zeit. für Hygiene, IX., 416. 1890.
4. Disinfection and Disinfectants, p. 162. 1888. Concord.

mercuric chloride, although for many purposes it is preferable to this salt. It is now generally used in Germany for the disinfection of the excreta of typhoid and cholera patients. It is not itself destroyed, and may be left indefinitely in contact with the material to be disinfected. Experiments show that a 1 per cent. solution destroys the cholera spirillum and the typhoid bacillus, as well as the various pus micrococci. So when we direct the use of a 5 per cent. solution we think we are on the safe side, and it has the advantage of being quite as effective in the presence of albumen as in its absence. It destroys spores after a very long exposure."[1]

Uffelmann[2] learned from his own experiments that a 5 per cent. solution of carbolic acid failed to destroy typhoid bacilli in one hour, but effected a complete sterilization in twenty-four hours.

Auxiliaries.—Experiments made by Laplace[3] of New Orleans, in Koch's laboratory show that the disinfecting power of solutions of carbolic acid is greatly increased by the addition of the mineral acids. Thus he found that "2 per cent. of crude carbolic acid with 1 per cent. of pure hydrochloric acid destroyed anthrax spores in seven days, while 2 per cent. of carbolic acid, or 1 per cent. of hydrochloric acid alone, did not destroy these spores in thirty days. A 4 per cent. solution of crude carbolic acid, with 2 per cent. of hydrochloric acid, destroyed spores in less than one hour; 4 per cent. of carbolic acid solution alone did not destroy them in twelve days."

The mixture of crude carbolic acid and sulphuric acid suggested by Laplace,—the mixture of the two liquids in equal quantities by weight,—was tested by Fränkel.[4] The mixture should be carefully prepared, else a high degree of heat is evolved, by adding the sulphuric acid gradually to the crude carbolic acid. Fränkel learned that the disinfecting strength of this mixture depends very much on whether it is or is not kept carefully cooled during its preparation. Prepared cold it is much more efficient than when it heats. Anthrax spores were killed within one day by the action of a 5 per cent. solu-

1. Brooklyn Medical Journal, III., 348. 1889.
2. Deutsche Med. Woch., XVI., 37. 1890.
3. Deutsche Med. Woch., XIII., 867. 1887.
4. Zeit. für Hygiene, VI., 521. 1889.

tion of the crude carbolic acid and sulphuric acid prepared cold, while the 5 per cent. solution of the mixture prepared hot required nine days to destroy them.

An objection to the use of the mixture of crude carbolic acid and sulphuric acid is the corrosive action of the latter.

In his paper on rendering crude carbolic acid soluble by means of soap solutions, Nocht[1] says that the stronger the solution of soap, the more carbolic acid is it capable of dissolving. At 60° C. a 3 per cent. solution of soap will dissolve 6 per cent. of carbolic acid, and a 6 per cent. soap solution will take up 12 per cent. of carbolic acid. While hot, the solutions are clear, but in cooling they become more or less turbid.

In his tests it was shown that the percentage of soap had nothing to do with determining the germicidal action of the solution. That was dependent alone upon the quantity of carbolic acid which was held in solution. Sporeless bacteria, cholera and typhoid bacilli, and staphylococcus aureus, were killed in half an hour in a cold solution containing 1.5 per cent. of carbolic acid. In practice it is best to use a 3 per cent. solution of soap at 40° or 50° C. (104° or 122° F.), into which up to 5 per cent. of the carbolic acid can be poured and a clear solution obtained. At the temperatures indicated, this solution can be used to disinfect clothing, leathern articles, etc. As showing the superior action of the hot solution, Nocht states that, using a 5 per cent. solution, anthrax spores survived an exposure of six days, but they were killed in six hours when the solution had a temperature of 50°.

In making the soap-carbolic acid mixture we are directed by Freund[2] to mix and stir 1 part of 100 per cent, carbolic acid (a crude carbolic acid) with 20 parts of hot solution of black soap (green or potash soap).[1]

There is some difficulty in understanding some of the foreign references to the trade designations of different grades of carbolic acid. Nocht refers to three kinds of carbolic acid,—crude, the so-called 100 per cent., and the pure liquefied. Crude carbolic acid is almost wholly insoluble in water, dissolving to the extent of only 2 to 4 per cent., but it is wholly soluble in a solu-

1. Zeit. für Hygiene, VII., 521. 1889.
2. Gesundheit, XX., 53. 1895.

tion of caustic soda. The effective agent in the crude carbolic acid is cresol.

Buchner[1] explains that 100 per cent. carbolic acid means only that it is wholly soluble in a solution of caustic soda. The quantity of carbolic acid and cresol represented by each trade designation is as follows:

25-30%	C.	A. has	2-3%	of	carbolic	acid	and	cresol.
40-60%	"	"	3-5%	"	"	"	"	"
80%	"	"	50%	"	"	"	"	"
100%	"	"	80%	"	"	"	"	"

Crude carbolic acid has 10-25 per cent. of phenol.

Koch[2] was the first to call attention to the fact that, when dissolved in oil or alcohol, carbolic acid has not the least disinfecting action, whether applied to spore-bearing or sporeless anthrax bacilli.

Lenti[3] confirms Koch's statement that carbolic acid in olive oil has no disinfectant power. Tested on anthrax spores a 10 per cent. solution of carbolic acid in absolute alcohol had no effect, but when the solution contained 70 per cent. of water, the anthrax spores were killed in forty-eight hours.

As to the action of glycerine, Lenti found that a 10 per cent. solution of carbolic acid in pure glycerine had no effect, but when the carbolic acid solution contained 80 per cent. of water, the spores were killed with certainty in forty-eight hours.

Epstein's[4] work indicated that solutions of carbolic acid, lysol, or thymol act more efficiently when made in 50 per cent. alcohol than when in absolute alcohol, in water, or in dilutions of alcohol above or below 50 per cent.

In a paper on the molecular conditions of aqueous solutions of disinfectants as regards their efficiency, Dr. Scheurlen[5] states that 1 per cent. solutions of carbolic acid or of the cresols in water failed to destroy Staphylococcus pyogenes aureus in five minutes, but 1 per cent. solutions of carbolic acid with 24 per cent. of common salt or 1 per cent. cresol with 12 or 13 per cent. of common salt, destroyed the same organisms in one minute.

1. Jr. für Gasbel. u. Wasserversorgung, XXXVI., 128. 1893.
2. Mittheil. a. d. Kais. Gesundh., I., 251. 1888.
3. Annali dell' Ist. d'Ig. Sper. della Univ. di Roma, III., (N. S.), 515. 1893.
4. Zeit. für Hygiene, XXIV., 1. 1897.
5. Archiv für Exper. Pathol. u. Phar., XXXVII., 74. 1896.

He found also that 1 per cent. carbolic acid with 12 and with 20 per cent. of common salt, and ½ per cent. as well as 1 per cent. o-cresol with 13 and again with 19 per cent. of common salt destroyed anthrax spores in three days at the latest, while these solutions without the addition of the salt had hardly the slightest effect upon the spores.

Upon his recommendation, certain surgeons have used the ½ per cent. solution of ortho-cresol with 12 per cent. of common salt as a very satisfactory antiseptic. The rusting of instruments in it can be prevented by the addition of 1:1000 of sodium thiosulphate (hyposulphite of sodium).

Repeating the experiments of Scheurlen, Beckmann[1] confirmed his results. With a culture of staphylococcus aureus, the addition of even 3 per cent. of common salt to a 1 per cent. solution of carbolic acid increased its disinfectant power very decidedly. On the other hand, when applied to anthrax spores a 1 per cent. solution of carbolic acid showed no increase in its germicidal power until 24 per cent. of common salt had been added. The addition of this proportion of common salt increased the efficiency of a 1 per cent. solution of carbolic acid so that it gave better results than a simple 6 per cent. solution in water.

Römer's[2] results were also confirmatory of those of Scheurlen. In his experiments a 3 per cent. solution of carbolic acid had but little effect upon anthrax spores in fifteen days, but in the same space of time they were completely killed with a 3 per cent. solution of carbolic acid to which 1 per cent. of common salt had been added. The addition of 4 per cent. destroyed them in nine days, and 8 per cent. in six days. The addition of 16 per cent. increased the efficiency of the 3 per cent. carbolic acid solution no more than 8 per cent. Römer found that sodium sulphate, sodium nitrate, and ammonium sulphate also augmented the action of carbolic acid solutions.

Heat as an Auxiliary.—We have already seen that, in the hands of Nocht, the time required for his soap-carbolic acid solution to kill anthrax spores was reduced from six days at the ordinary room temperature to six hours at the temperature of 50° C. (122° F.). Extending his investigation in the same

1. Centr. für Bak., XX., 16, 17. 1896.
2. Münchener Med. Woch., XLV., 298. 1898.

direction, so far as concerns the influence of a moderate increase in temperature, Heider[1] learned that while the anthrax spores used by him resisted the action of a 5 per cent. solution of carbolic acid thirty-six days at ordinary room temperature, at 55° C., they were killed in from one to two hours, and at 75° C. in three minutes. At 75° C., even a 3 per cent. solution destroyed them in fifteen minutes.

Disinfection of Excreta.—In testing the comparative value of carbolic acid, creolin, and lysol, Remouchamps and Sugg[2] found that in the presence of albuminous matter carbolic acid and lysol were superior to creolin. With typhoid stools and artificial cholera stools, when a 2.5 per cent. solution of these three disinfectant agents was applied in a volume equal to that of the matter to be disinfected, there was no difference in the efficiency of the three.

In the experiments of Vincent[3] a 1 per cent. solution of carbolic acid destroyed most of the saphrophytic bacteria, but a 3 per cent. solution was required to kill B. coli commune.

Laplace's mixture of crude carbolic acid and sulphuric acid is undoubtedly an efficient disinfectant and deodorant for fecal matter, but its preparation is somewhat troublesome.

Disinfection of Tuberculous Sputum.—The investigations of Schill and Fischer[4] indicate that carbolic acid is a trustworthy disinfectant for fresh tuberculous sputum, provided the solution used is as strong as 5 per cent. and has a chance to act not less than twenty-four hours.

Jaeger[5] recommends for the destruction of the bacillus of tuberculosis Laplace's 4 per cent. solution of crude carbolic acid with 2 per cent. of hydrochloric acid (8 cc. of 50 per cent. crude carbolic acid, 2 cc. of hydrochloric acid, and 90 cc. of water), or the mixture of crude carbolic acid and sulphuric acid also suggested by Laplace. The experiments of Jaeger were not, however, made with fresh sputum in quantity, but with the bacillus on silken threads.

1. Centr. für Bak., IX., 221. 1891.
2. Mouvement Hyg.—Hygienische Rundschau, I., 436. 1890.
3. Annales de l'Inst. Past., IX., 23. 1895.
4. Mittheil. a. d. Kais. Ges., II., 145. 1884.
5. Arbeiten a. d. Kais. Ges., V., 276, 292. 1889.

Comparison with Other Coal-Tar Derivatives.—Various other coal-tar products have been recommended as substitutes for carbolic acid.

Crude Carbolic Acid.—Cresol is its effective constituent. The work of Laplace, Nocht, Fränkel, and others indicates that solutions of crude carbolic acid with mineral acids or with soap are as efficient as solutions of the pure acid, or more so.

Cresol.—Obtained from crude carbolic acid. Tested on anthrax spores and the staphylococcus of suppuration, Vahle[1] concludes that Raschig's cresol and carbolic acid are very nearly equal in their action. Gruber[2] considers the cresols far superior to carbolic acid. Behring[3] says that cresol exceeds carbolic acid only in liquids containing no albumen. Buttersack's[4] experiments seem to indicate that the disinfecting power of cresol is somewhat higher than that of carbolic acid. Hammerl[5] says that, in solutions of equal per cent., cresol has twice as strong a disinfecting action as carbolic acid. Cresol, so says Heider,[6] has greater disinfecting power than carbolic acid. Hammer[7] rates cresol higher than carbolic acid as a disinfectant. As to toxicity, the results of Grigorjeff's[8] experiments confirm the assertion of Delplanque that tricresol is four times less toxic than carbolic acid. Some experiments made by Dr. C. O. Avery[9] indicate that tricresol is a very safe antiseptic.

Lysol.—Consists of neutral potash soap, water, and cresols. Remouchamps and Sugg[10] think there is little difference between lysol and carbolic acid as regards their germicidal action. Laser[11] quotes Schottelius as recommending lysol for the disinfection of excreta as more efficient than carbolic acid. Vincent[12] ranks lysol a little more active than cresol. Pohl[13] concludes that lysol is more efficient than carbolic acid. Lingelsheim[14]

1. Hyg. Rundschau, III., 901. 1893.
2. Archiv für Hygiene, XVII., 618. 1893.
3. Zeit. für Hygiene, IX., 420. 1890.
4. Arbeiten a. d. Kais. Ges., VIII., 359. 1892.
5. Archiv für Hygiene, XXI., 198. 1894.
6. Archiv für Hygiene, XV., 341. 1892.
7. Archiv für Hygiene, XII., 359. 1891.
8. Beitr. zur Path. Anat. u. z. all. Pathol.—Centr. für Bak., XVII., 853. 1895.
9. The Medical News, LXVII., 68. 1895.
10. Revue D'Hygiene, XIII., 640. 1891.
11. Centr. für Bak., XII., 232. 1892.
12. Annales de l'Inst. Past., IX., 26. 1895.
13. Ein. Beintrag zur Kentnis der disinfect. Eigenschaft des. Lysol. 1893.
14. Quoted by Pohl.

found that, applied to streptococci, lysol is more effective than creolin. Freund[1] thinks lysol more efficient than carbolic acid. Heider[2] finds that when containing the same percentage of cresol, lysol does not destroy anthrax spores so rapidly as solveol or solutol. Hiller[3] rates lysol lower than solveol as an antiseptic.

Creolin.—An emulsion of the cresols of crude carbolic acid in a solution of hard soap. As a surgical antiseptic Behring[4] says it is inferior to carbolic acid. Its action is hindered by albumen. Ermengem[5] ranks it above carbolic acid as a germicide. Hunermann[6] concludes that creolin is not so efficient as carbolic acid for anthrax bacilli or the bacteria of suppuration.

Solveol.—Said to be a neutral, aqueous solution of cresol rendered soluble by means of cresolinate of soda. Used for surgical purposes principally. Hiller[7] deems it the most desirable antiseptic, and superior to carbolic acid. He quotes the results obtained by Hammer as showing that a solution of solveol containing 0.5 per cent. of cresol, outranks lysol, creolin, and even carbolic acid in 2.5 per cent. solutions.

Solutol.—A watery solution of cresol in which sodium cresolate is used to render the cresol soluble. Adapted to gross disinfection. For the disinfection of slaughter-houses and stables, H. Koch[8] found solutol to be the best disinfectant. It penetrates the interior of masses of coagula of blood and other material more rapidly than lysol. In Buttersack's[9] experiments crude solutol destroyed anthrax spores much more promptly than other forms of cresol, and very much more quickly than carbolic acid. A solution of solutol containing 5 per cent. of cresol, in Heider's[10] hands killed anthrax spores in one hour at 55° C. temperature. Hammer, as quoted by Laser,[11] says that solutol is superior to lysol.

Toxicity.—There seems to be a consensus of opinion that carbolic acid is more poisonous than the cresols. Comparing the

1. Gesundheit, XX., 51. 1895.
2. Archiv für Hygiene, XV., 370. 1892.
3. Deutsche Med. Woch., XVIII., 841. 1892.
4. Bekampfung der Infectionskrankheiten, II., 110. 1894.
5. Centr. für Bak., VII., 75. 1890.
6. Centr. für Bak., V., 650. 1889.
7. Opus cit.
8. Hygienische Rundschau, III., 233. 1893.
9. Arbeiten a. d. Kais. Ges. VIII., 369. 1892.
10. Archiv für Hygiene, XV., 1892.
11. Centr. f. Bak., XII., 231. 1892.

three agents in this respect Remouchamps and Sugg[1] state that carbolic acid is more poisonous than lysol or creolin. As determined by them the fatal dose per kilogram of rabbit is 0.30 for carbolic acid, 1.10 for creolin, and 2.00 for lysol. As quoted by Pohl,[2] Peé decided that carbolic acid is eight times, and creolin more than twice as poisonous as lysol.

Solutions and Uses.—Solutions of carbolic acid in oil, alcohol, or glycerin have very little disinfecting power. Laplace's mixture of crude carbolic acid and sulphuric acid is efficient, but the range of its applicability is limited. The solution of crude (100 per cent.) carbolic acid suggested by Nocht, might well find a somewhat extended use. Solutions of carbolic acid with hydrochloric acid are more efficient than without it, but the irritating and corrosive action of acid solutions renders them undesirable for many purposes. It appears that the addition of common salt to solutions of carbolic acid increases their efficiency, and this addition might, therefore, be made to solutions for various uses.[3]

For the disinfection of clothing and for some other purposes, a 2 per cent. solution of carbolic acid was recommended by the first Committee of the American Public Health Association, to act four hours. Particularly when clothing can subsequently be boiled, this would be ample. For excreta, tuberculous sputum, or for the dead, a 5 per cent. is none too strong, and when the application is to be but momentary, as in washing walls or furniture, carbolic acid is of doubtful trustworthiness.

CATTLE CARS. (See VETERINARY PRACTICE.)

CHINOSOL.

Dr. H. Ostermann,[4] of Hamburg, has used chinosol and finds it a very convenient as well as efficient antiseptic in gynocologic and obstetric practice. It can be obtained in the form of tablets, it is readily soluble, is but slightly toxic, is odorless, and the solutions used by him (0.5:1000 to 2:1000) are not irritating. For the disinfection of the hands his experiments show that it

1. Mouvement Hyg.—Hygienische Runds., I., 486. 1890.
2. Op. cit.
3. See page 191.
4. Therapeutische Monatshefte, X., 154. 1896.

is efficient, particularly after the preliminary preparation of the hands with soap and water and with alcohol.

Ahlfeld and Vahle[1] tested crinosol clinically and bacteriologically. Solutions of a strength even up to 3 per cent. were found wholly untrustworthy for the disinfection of the hands. It was, however, found to have marked antiseptic power, but in contrast with the results of Emmerich, the antiseptic action was not distinct with a smaller proportion than 1:20,000. Their results indicate that, when tested on bouillon cultures of Staphylococcus pyogenes aureus, chinosol has no great disinfecting power.

Kossmann,[2] of Berlin, criticises unfavorably the methods pursued by Ahlfeld and Vahle and refers to the favorable results obtained in the bacteriological tests made in the Analytical Laboratory of Apothecaries' Hall, London.

Witte,[3] of Berlin, finds that chinosol is painfully irritating when applied in powder to raw surfaces, and that it stains clothing and the hands badly. He refers to the statement of Professor Emmerich that the growth of Staphylococcus pyogenes aureus is distinctly inhibited by 1:40,000 of chinosol.

The experiments of Bonnema,[4] of Holland, indicate that chinosol is not an efficient germicide. Among pathogenic bacteria he tested it upon Staphylococcus pyogenes aureus only.

As it has been affirmed that the antiseptic power of chinosol is forty times greater than that of carbolic acid and even superior to that of corrosive sublimate, Professor Giovannini[5] tested its ability tò prevent the development of the bacillus of syphilis (Ducrey's bacillus) upon inoculated surfaces,—auto-inoculation. He found that, for this purpose, it is far inferior to corrosive sublimate; and much less efficient than carbolic acid, though his data for the latter comparison were meagre.

As stated by an English journal,[6] Mr. C. G. Moor tested the action of chinosol on the bacteria of typhoid fever, diphtheria, anthrax, cholera, and on the chief organism of pus. His results show the germicidal power to be so great that even the tenth of an ounce in three gallons of water makes a reliable disinfecting

1. Centralblatt für Gynokologie, XX., 235 1896.
2. Centr. für Gynokologie, XX., 869. 1896.
3. Centr. für Gynokologie, XX., 233. 1896.
4. Therapeutische Monatshefte, X., 663. 1896.
5. Deutsche Med. Woch., XXIII., 585. 1897.
6. The Sanitary Record, XXI., 117. 1898.

solution. It is further stated that Dr. Klein has investigated the action of chinosol on bacillus subtilis, on anthrax spores, and on the Staphylococcus pyogenes aureus, and that he states that a 1 per cent. solution of chinosol is fatal to them in five minutes, whereas they live for forty-eight hours in carbolic acid of five or six times the strength.

CHLORID OF LIME (HYPOCHLORITE OF CALCIUM.

"Especial care," says Dr. Sternberg,[1] "will be required in the practical use of the oxidizing disinfectants, such as potassium permanganate and the hypochlorites of calcium and sodium. These agents owe their power to the fact that they are promptly decomposed by contact with organic matter but this decomposition is entirely a chemical reaction, and only a given amount of organic material can be oxidized by a given quantity of the oxidizing agent; on the other hand, the disinfecting power of such agents is neutralized by a given quantity of organic material, whether this is in the form of living micro-organisms, or of dead animal or vegetable matter. If, then, the organic material is in excess, germs embedded in it will escape destruction, and the only safe rule in the practical use of oxidizing disinfectants is to *use such a quantity of the disinfecting agent that it shall be in excess after the reaction has taken place.*"

He had already demonstrated that the very resistant organisms in putrid beef tea are destroyed with chlorid of lime, and further experiments showed its capability of sterilizing fecal matter.

One pint of solution of chlorid of lime, with 0.65 per cent. of available chlorin, failed to sterilize 4 ounces of semi-solid feces in twenty-four hours. No chlorin remained. Two quarts of solution with 0.85 per cent. of available chlorin added to 7 ounces of semi-solid feces, sterilized completely. A trace of chlorin remained.

In later experiments cultures of the bacillus of typhoid fever, cholera spirillum, anthrax bacillus *with spores,* Staphylococcus pyogenes aureus, and other organisms were almost invariably destroyed with a 1 per cent. solution of chlorid of lime. It is recommended by the committee of 1885 as one of the most efficient of chemical disinfectants.

1. Disinfection and Disinfectants, pp. 84, 153. 1888. Concord.

In the experiments made for the Imperial Board of Health of Germany, Koch[1] tested a 5 per cent. solution of chlorid of lime on anthrax spores with unfavorable results. This is apparently the reason why this agent has been so little used in many European countries. There is, however, in Koch's report nothing to indicate whether the tests were few or many, or what percentage of chlorin was available in the chlorid of lime used by him.

Behring[2] too affirms that, though chlorid of lime has some bactericidal action, its power in this direction is about twenty times less than that of caustic lime. He adduces no experiments. In a later work,[3] however, after the results of Nissen's work had been reported, he found no great disparity in the disinfectant power of the two agents, but still shows a personal preference for caustic lime.

The careful work of Nissen[4] tended to confirm the value which Dr. Sternberg and the Committee of the American Public Health Association had ascribed to chlorid of lime. Nissen's experiments were made with pure cultures of the bacillus of typhoid, of cholera, of anthrax, and Staphylococcus pyogenes aureus, and Streptococcus erysipelatis. The micro-organisms were in bouillon with 1 per cent. of peptone and 0.5 per cent. of common salt.

Typhoid bacilli were destroyed with certainty in five minutes when the bouillon contained not less than 0.12 per cent. of chlorid of lime whether the mixture was filtered or not. Cholera bacilli were always killed in five minutes and in most cases in one minute.

Nissen refers to the results obtained by Liborius and Kitasato with caustic lime, and states that the action of chlorid of lime is much more rapid.

Anthrax bacilli without spores were destroyed in one minute with a 0.1 per cent. solution; and streptococcus just as quickly when the bouillon contained 0.2 per cent. of chlorid of lime.

Solutions of chlorid of lime were found to lose their disinfectant power rapidly when used on anthrax spores. This was

1. Mittheil. a. d. Kais. Ges., I., 264. 1881.
2. Zeit. für Hygiene, IX., 408. 1890.
3. Bekampfung der Infectionskrankheiten, II., 92. 1894.
4. Zeit. für Hygiene, VIII., 62. 1890.

observed even in ten, fifteen, and thirty minutes after they were prepared.

The anthrax spores first used were not of a very resistant kind. On threads they were occasionally killed in five minutes with a 5 per cent. solution; they were often killed in fifteen minutes, and almost always in thirty minutes. The author received from Nocht some very resistant spores. Dried on silken threads they retained their vitality four hours in a 1 per cent. solution of sublimate, the precautions of Geppert being observed. They were killed in twelve minutes in flowing steam, but not in ten minutes. In a 5 per cent. filtered solution of chloride of lime, they were destroyed in four hours and a half.

Pure cultures of typhoid fever in sterilized feces were disinfected completely in two minutes with 1 per cent. or 0.5 per cent. of chlorid of lime.

On cultures of typhoid fever in equal parts of sterilized blood serum and sterilized feces 0.5 per cent. of chlorid of lime had no effect in fifteen minutes; but 1 per cent. of the disinfectant sterilized in five minutes. The various experiments showed that chlorid of lime, whether as powder or in solution, added to diarrheal feces in the proportion of 0.5 per cent. always destroyed typhoid bacilli in ten minutes.

For the disinfection of fresh typhoid or cholera stools with caustic lime, Pfuhl states that one hour is required. Disinfection of the same may be accomplished in a few minutes with chlorid of lime. Chlorid of lime thus has the advantage over caustic lime of disinfecting in a much shorter time.

Nissen says that chlorid of lime may be added in the form of powder to dejections at the rate of 0.5 per cent. of the volume of the matter to be disinfected, or, taking into consideration the difference in the quality of the chlorid of lime, 1 per cent. may be added (1 gram to 100 cc.) The stool may be emptied in ten minutes after the addition of the chlorid of lime.

In the tests of various agents for the rapid disinfection of stalls and cattle cars, Jaeger[1] found that the bacteria of chicken cholera, erysipelas of swine, hog cholera, and anthrax were destroyed with a 1 per cent. solution of chlorid of lime. But anthrax spores required a mixture, or milk of chlorid of lime

1. Arbeiten a. d. Kais. Ges. V., 272. 1889.

of 1:3, and this in one experiment failed to kill the bacillus of glanders. Its action even in this strength was uncertain with the tubercle bacillus. Jaeger's judgment is that chlorid of lime is a very efficient disinfectant.

Vincent[1] ranks chlorid of lime as one of the best of chemical agents for the disinfection of excreta, though he does not place it first in point of efficiency. The chlorid of lime used in his experiments showed by titration 110 litres of chlorin in each kilogram. A saturated solution was used. To completely sterilize diarrheal stools, 10 per cent. of their volume of this saturated solution was required; and the same proportion was required to destroy Bacterium coli commune in a mixture of normal feces and urine.

Sometimes the destruction of the bacillus of typhoid fever in typhoid stools may be accomplished in seven hours with from 6 to 8 grams of chlorid per 1000 cc. of fecal matter; but to destroy this bacillus with certainty in twenty-four hours, 12 grams per 1000 must be used.

The cholera bacillus is easily destroyed with chlorid of lime. To do it with certainty a quantity of the saturated solution equal to 10 per cent. of the matter to be disinfeced is required, or 8.3 grams of the chlorid per 1000 cc. of material to be disinfected.

In the disinfection of vaults Vincent recommends acidifying their contents with commercial hydrochloric acid, before adding the chlorid of lime.

Applications.—The most frequent use of chlorid of lime is in the disinfection of excreta. With an excess of this agent, as Sternberg advises, the pathogenic organisms in excreta may be rapidly destroyed. To accomplish this result, there must be an intimate mixture, by stirring or otherwise, of disinfectant with material to be disinfected. Chlorid of lime is an efficient deodorant, but its own smell is substituted, which is very disagreeable to many persons.

A solution may be used for the disinfection of the dead, by saturating with it the sheet in which the corpse is to be enveloped. For the disinfection of tuberculous sputa, there is room for doubt as to its trustworthiness. Its odor is also objectionable. Whether the "milk of chlorid of lime" may be trusted

1. Annales de l'Inst. Past., IX., 12. 1895.

in veterinary practice to disinfect stalls infected with tuberculosis or glanders, further experiments seem to be needed to decide the question.

For the purpose of destroying typhoid fever germs in the mains of the water-works in Maidstone, Eng., Dr. Sims Woodhead dissolved about ten tons of chlorid of lime in 240,000 gallons of water in the reservoir and allowed the solution to flow into the mains. At a certain hour it was turned into all the house connections in the district.

Comparisons.—As may be seen by an examination of the results of the experimental tests of caustic lime and chlorid of lime, most of the later work and that of Dr. Sternberg indicate that chlorid of lime is the more rapidly active of the two.[1] In point of efficiency in the disinfection of excreta, Vincent places the cresols and sulphate of copper first, and chlorid of lime next, with caustic lime considerably lower. In point of cost, he places chlorid of lime first as being the cheapest. Nissen's estimate is that from 0.5 to 1 per cent. of chlorid of lime is required to disinfect sterilized feces with typhoid bacilli. Pfuhl found that 1.5 per cent. of caustic lime is required to produce the same effect. We may entirely disregard Behring's former opinion that the germicidal power of chlorid of lime is not more than one twentieth of that of caustic lime.

Preparations.—The solution recommended by the Committee of the American Public Health Association is made by adding six ounces of chlorid of lime to one gallon of water. This is approximately a 4 per cent. solution. Solutions of chlorid of lime lose their strength rapidly; they should, therefore, be freshly prepared, but if well corked may be kept several days. Exposed to the air chlorid of lime soon loses a large part of its disinfecting power. It should, therefore, be preserved in airtight receptacles.

CHLORIN GAS.

Chlorin has, according to Rideal,[1] three possible modes of action. 1. It may replace hydrogen in the organic substances, forming innocuous compounds and poisoning the bacteria. Such action is slow. 2. The offensive gases of putrefaction are decomposed by chlorin,—sulphuretted hydrogen, phosphoretted

1. Disinfection and Disinfectants, p. 58. 1895. London.

hydrogen, ammonia, and compound ammonias. 3. The common and most important action of chlorin is as an oxidizing agent. In the presence of water, more especially in light, it combines with hydrogen to form hydrochloric acid, and liberates oxygen. The oxygen so formed is far more active than atmospheric oxygen, and is in a condition to burn up the putrescent matters and kill the organisms which accompany the putrefaction. But there are several conditions indispensable to thorough disinfection, and amongst these *the presence of moisture* is absolutely essential when chlorin fumigation is resorted to.

In Koch's[1] comparative tests of bromin and chlorin he found that bromin is more rapidly active than chlorin. Chlorin gas did not kill anthrax spores in less than two days, while bromin, under the same conditions (a damp atmosphere), destroyed them in one day. Immersed in chlorin water, or 2 per cent. solution of bromin, anthrax spores were destroyed in one day. As a gaseous disinfectant, Koch found chlorin gas more efficient than sulphur dioxid.

Fischer and Proskauer[2] took up the work with chlorin, for the Imperial Board of Health, where Koch had left it and sought to determine more definitely the efficiency and the limitations of chlorin in the disinfection of rooms. The gas was used at various concentrations from 1:25,000 to 1:2.5 of air, the air in the experimental chamber being sometimes dry and sometimes damp.

It required twenty-four hours for 44.7 parts of chlorin in 100 parts of air to destroy anthrax spores, the spores and the chlorin atmosphere being dry. But when the air and the spores were moistened, complete sterilization was effected in one hour with 4 per cent. of chlorin. Anthrax bacilli were destroyed in twenty-four hours with 1:2500 of chlorin, moisture being present. In practical experiments in rooms they found it was impossible to secure the same certitude of action as was practicable in flasks where definite preportions of the chlorin could be used. These investigators also determined the action of the gas upon various fabrics. The following are some of the points in their concluding remarks:

1. **Mittheil. a. d. Kais. Ges., I., 273. 1881.**
2. **Mittheil. a. d. Kais. Ges., II, 228. 1884.**

Chlorin gas has a narrow range of applicability in disinfection. It has but little power of penetration. Compared with sulphur fumigation, chlorin is more efficient. Most things are injured by the action of chlorin. Moisture increases the efficiency of chlorin, but, at the same time, adds very much to its destructive action on clothing, metals, etc. Clothing, particularly, must not be subjected to the action of chlorin.

Sternberg says that, "chlorin gas is the most effective gaseous disinfectant without doubt, but there are certain disadvantages in its application; it is irritating, corrosive, and bleaches and destroys fabrics. It would not do, for instance, to turn chlorin gas loose in one of our nicely finished ships, as it would do a great deal of damage to paint and brass work, and also to the hangings and furniture; but where it is applicable it is the best gaseous disinfectant."[1]

Dr. Rohé summed up very judiciously the case of chlorin for the Committee on Disinfectants:

"Chlorin is an efficient disinfectant when present in the proportion of 1 part in 100, provided the air and the objects to be disinfected are in a moist state, and the exposure continues for upwards of one hour.

"Chlorin, when used in sufficient concentration to act as a trustworthy disinfectant, injures colored fabrics and wearing apparel.

"The use of chlorin, and in a greater degree of bromin, requires considerable experience in management. When carelessly handled they may cause inconvenient, or even dangerous symptoms in persons using them. For these reasons they are not suitable as disinfectants for popular use."[2]

Uses of Chlorin.—"For each cubic metre of space use 0.35 kilograms of hydrochloric acid and 0.25 kilograms of freshly prepared chlorid of lime. Let the gas act eight hours at least. Its action is hardly more efficient than that of sulphurous acid" (Von Esmarch[3]). Chlorin gas was not included in the disinfecting agents recommended by the Committee on Disinfectants of the American Public Health Association.

1. Brooklyn Med. Jr., III., 344. 1889.
2. Report of Committee on Disinfectants, A. P. H. A., p. 26. 1888.
3. Hygienisches Taschenbuch, p. 208. 1896.

CHLOROFORM.

In Koch's[1] experiments immersion in chloroform one hundred days did not suffice to destroy the vitality of anthrax spores. Behring[2] states that the bacillus of anthrax, and of typhoid fever, the spirillum of cholera, and Staphylococcus pyogenes aureus are all very quickly killed with chloroform; that 1 per cent. of chloroform will kill the spirillum of cholera in less than one minute; that ¼ per cent. will kill the same micro-organism in one hour; and that ½ per cent. will destroy typhoid bacilli in one hour. He recommends chloroform water as a mouth wash.

CLOTHING.

The most trustworthy agency for the disinfection of clothing is moist heat,—steam or boiling. Those woolen or other goods that would be injured by boiling, or by maceration in liquid solutions, may be disinfected in steam disinfectors of quite simple construction, provided an abundance of steam streams through the disinfecting chamber. Subjection to boiling for half an hour insures the disinfection of all clothing that can be so treated.

When infected bed or body linen is removed, it may be treated differently according to circumstances. If stained, it should be soaked some hours in a disinfecting solution at a temperature not exceeding 120° F. A 2 per cent. solution of lysol is very suitable for this purpose. Subsequent boiling, as in the ordinary laundry processes, will complete the sterilization. Unstained clothing may be immersed in a disinfecting solution and treated as already advised, or it may be transferred immediately to the wash-boiler or steam disinfector or to hot disinfecting solutions.

Clothing which has been immersed in a disinfecting solution or is otherwise wet, is not readily penetrated by the heat in steam disinfection. In transferring infected clothing from the sick room, it should be wrapped in a sheet wet in a disinfecting solution or in simple water, if the disinfecting solution is not at hand.

Colored goods and the garments for outside wear generally, may be disinfected with steam, or by maceration in a 3 per cent.

1. Mittheil. aus dem Kais. Ges., I., 263. 1881.
2. Bekampfung der Infectionskrankheiten, II., 107. 1894.

solution of carbolic acid, or a 2 per cent. solution of lysol, or a 1:1000 solution of corrosive sublimate. Maceration in simple sublimate solution is no more likely to change the colors of goods than soaking in water alone. The solution of lysol changes the colors of some fabrics. It has about the same effect as soaking in soap and water would.

It is quite likely that solutions of formaldehyde will be found efficient in the disinfection of clothing. A 5 per cent. solution of formalin changes colors but very little, not more than a 5 per cent. solution of carbolic acid, or the 1:1000 solution of corrosive sublimate.

COPPER SALTS.

Dr. Green,[1] of Hanover, Germany, investigated the disinfective power of crude and pure sulphate of copper, bichlorid of copper, nitrate, acetate, and aluminate of copper, sulpho-carbolate of copper, and ammonio-copper sulphate. He finds that all of these salts, with the exception of the bichlorid, precipitate albumen as corrosive sublimate does. There should, therefore, be the same limitations in the use of all the copper salts, except the bichlorid, as there is in the use of sublimate when albumen is present. He found that the bichlorid is more efficient than the sulphate and the other copper salts, particularly in albuminous liquids.

On account of the action of copper salts upon metals and their staining of fabrics, the use of them must be limited almost exclusively to the disinfection of excreta. For the disinfection of cholera and typhoid dejections in the sick-room, the vessel should contain before use about four times the bulk of the dejections of a 5 per cent. solution of copper bichlorid, and it should stand at least an hour before it is emptied.

Summarizing his results he says:

The soluble copper salts, and particularly copper bichlorid has considerable disinfecting value. Anthrax spores were not destroyed in less than thirty days, or, at least, none of the salts except copper bichlorid would destroy them in less time; sporeless infectious matter, on the contrary, was destroyed in a much shorter time.

1. Zeit. für Hyg., XIII., 495. 1893.

In albuminous solutions, copper bichlorid alone is suitable. With the other salts an insoluble albuminous precipitate ensues. In surgical work, the treatment of wounds, copper bichlorid is far preferable to copper sulphate which is sometimes used.

Cholera and typhoid bacilli were destroyed with certainty with copper bichlorid in not less than two hours, staphylococcus aureus in not less than five hours, in bouillon.

COPPER SULPHATE.

In the experiments of Dr. Sternberg[1] for the Committee of the American Public Health Association, sulphate of copper failed to disinfect material containing spores, but it readily destroyed sporeless bacteria. In later work a large number of sporeless organisms in bouillon, including the bacillus of typhoid fever and of cholera, and staphylococci, and streptococci, were invariably killed with 1 per cent. of sulphate of copper. The addition of 10 per cent. of albumen lessened the disinfecting action of the copper salt in a marked degree.

In an extensive series of experiments made by Gerloczy[2] in the Hygienic Institute of Buda-Pesth, sulphate of copper, sulphate of zinc, crude carbolic acid, creolin, crude sulphuric acid, milk of lime, potash lye, and other agents were tested. He found sulphate of copper to be a very efficient disinfectant. Added to sewage in the proportion of 1:1000, it rendered it odorless, and it remained permanently sterile. When used in sufficient quantity fresh excreta and even the contents of privy vaults were disinfected. For privy vaults he recommends a strong solution, at the rate, at least of 40 kilograms of sulphate of copper to each cubic meter of material to be disinfected (2½ pounds. to each cubic foot). For discharges from the bowels in the sick room, one part of the copper salt to one hundred parts of excreta is sufficient.

Vincent[3] warmly recommends sulphate of copper as the most efficient for excreta tested by him. In privy vaults it destroyed with certainty pathogenic bacteria, Bacterium coli commune, and the bacillus of putrefaction. For the complete disinfection of

1. Jr. Am. Pub. Health Assoc., XI., 225. 1885.
2. Deutsche Viert. f. öff. Ges. XXI., 433. 1889.
3. Annales de l'Inst. Past., IX., 81. 1895.

fecal matter in twenty-four hours, from 7 to 8.5 grams to 1000 cc. of fecal matter were required, but for the same quantity of typhoid stools, 5 grams, or of cholera stools, 4.5 grams, were found to suffice. The activity of cupric sulphate was increased by the addition of sulphuric acid.

Comparisons.—The range of applicability of sulphate of copper is rather limited. It may be used for the destruction of the germ of typhoid fever or of cholera in fresh excreta or in privy vaults. Chlorid of lime, however, is cheaper and probably will be found to act with greater rapidity. Milk of lime is also cheaper, and when it can be given sufficient time to act, may be deemed efficient, though Vincent ranks its degree of efficiency far below that of sulphate of copper. One consideration, in some places, in favor of lime is that it is not injurious to vegetation, while sulphate of copper is. For the disinfection of fecal matter, in the sick-room or in vaults, some of the cheaper cresol solutions, solutol, creolin, soap or acid solutions of crude carbolic acid, or, when time may be given, saprol, will probably be determined to be preferable to sulphate of copper, on account of lower cost, greater or equal efficiency, and more pronounced deodorizing qualities.

CORPSES.

The disinfection of corpses may be accomplished by wrapping them in sheets wet in a 3 or 4 per cent. solution of chlorid of lime, or of a solution of sodium hypochlorite (1 part of Labarraque's solution to 9 of water).

Carbolic acid is not so trustworthy. The cresols are more active germicides, and their efficiency as well as that of carbolic acid, can be augmented by the addition of common salt to their solutions. (See pages 191-192.)

A 5 or 10 per cent. solution of formalin would probably be efficient.

Solutions of mercuric chlorid have been much used, but their action extends no farther than the solution penetrates. The antiseptic and germicide action of solutions of the hypochlorites (including chlorid of lime) and of formaldehyde are increased by their vapors which are diffusible and far-reaching.

When it is deemed best to fill the space between the casket and the outside box with sawdust or other absorbent material, a

solution of formalin or of the hypochlorites would be a suitable and efficient one with which to dampen it.

The ordinary processes of the embalmer's art cannot be classed among the methods of disinfecting corpses. All unnecessary operations preceding the wrapping of the corpse in the disinfecting sheet and the packing with disinfecting material, facilitate the scattering of infection.

CORROSIVE SUBLIMATE. (See MERCURIC CHLORID).

CREOLIN.

The constituents of creolin, to which its disinfectant power is chiefly due, are the cresols dissolved, or rather emulsified in a solution of hard soap. Two kinds of creolin were put upon the market: an English preparation, Pearson's, and one of German manufacture, Artmann's. The latter has repeatedly been shown to have but slight value as a disinfectant and will, therefore, receive no further notice. Pearson's creolin contains about 10 per cent. of cresols with a small quantity of carbolic acid. Mixed with water a dirty-colored, milky mixture results.

As to the bactericidal powers of creolin, Ermengem[1] found a 5 per cent. solution to be a trustworthy disinfectant for cholera and typhoid germs, and for the streptococcus of erysipelas and Staphylococcus pyogenes aureus. He regards creolin as a disinfectant of the first rank, and one which is decidedly superior to carbolic acid. It is also commended as a deodorant.

Laser[2] confirms the statement of Ermengem that a 5 per cent. solution may be trusted to disinfect stools, and further commends it for its deodorant qualities and for its safety and cheapness.

Remouchamps and Sugg[3] conclude that a 2.5 per cent. solution of creolin is an efficient disinfectant agent for typhoid stools and artificial cholera stools. In the presence of albumen, however, creolin suffers the loss of some of its germicide power.

1. Bul. de l'Acad. Roy. de Med. de Belgique.—Centr. für Bak., VII., 75. 1890.
2. Centr. für Bak., XII., 232. 1892.
3. Op. cit.

In the experiments of Santovecchi,[1] a 1 per cent. solution of creolin destroyed the bacillus of typhoid fever in one minute. He found that light and heat have no effect upon the keeping qualities of creolin. On the other hand, Behring states that creolin freshly prepared is more efficient than old.

Watery solutions of creolin up to 60 per cent., in the experiments of Sirena and Alessi,[2] failed to kill anthrax spores. On the other hand, a 2 per cent. solution destroys the bacillus of hog-erysipelas in twenty-four hours, and a 10 per cent. solution destroys sporeless anthrax bacilli in fresh blood in ten minutes.

As a numerical statement of the comparative germicide power of carbolic acid, cresol, and creolin in bouillon, Behring[3] classes them as 1, 4, and 10, respectively. Thus in the absence of albuminous matter, the disinfectant power of creolin greatly exceeds that of carbolic acid, but under different conditions, when albumen is present, carbolic acid is 3 or 4 times more efficient than creolin.

The conclusions of Hünermann[4] are that creolin is not so effective as carbolic acid on either sporeless anthrax bacilli or the staphylococcus of suppuration.

Excreta.—As a disinfectant for fecal matter the results of the experimental work already cited, indicate that creolin is a trustworthy agent, and it is moreover an excellent deodorant. There are, however, reasons for apprehending that the inhibitory action of creolin has to some extent been mistaken for a germicide action.

Surgical.—Creolin has been recommended and used as a surgical antiseptic, but others of the cresol preparations are far preferable to it. For Pearson's creolin Esmarch and Eisenberg found its antiseptic value to be 1:5000 to 1:15,000, while Behring[5] found it to be not more than 1:175 to 1:225. Behring, therefore, attributes an antiseptic value to creolin about 50 times lower than that of these other investigators. The explanation of this discrepancy is that Behring's tests were made with bacteria in blood serum, an albuminous medium, while the other

1. Centr. für Bak., XIII., 413. 1893.
2. La Riforma Med.—Centr. für Bak., XII., 178. 1892.
3. Bekampfung der Infectionskrankheiten, II., 110-113. 1894.
4. Centr. für Bak., V., 650. 1889.
5. Deutsche Med. Woch., XV., 869. 1889.

experimenters used non-albuminous media. The difference in the character of the media, on the other hand, affects the value of carbolic acid but little. Its antiseptic value is generally estimated at from 1:600 to 1:900.

As to which method is the correct one for estimating the antiseptic value of disinfectants, Behring[1] reminds us that, when used in surgical work, they are brought into contact with blood, pus, and the serous exudations from wounds, all of which are albuminous. The antiseptic value of an agent determined in blood serum should, therefore, be the more correct one. Elsewhere he affirms that, "in surgical practice, where the antiseptic is to come in contact with the secretions from wounds, or in any case in the presence of albumen, carbolic acid is preferable to creolin."

As an antiseptic for anthrax spores Hünermann found that, in bouillon, 1:10,000, and in nutritive gelatin 1:5000 prevented their development, while for Staphylococcus pyogenes aureus, 1:1000 in bouillon, and 3:10,000 in gelatin were required. Thus, according to this experimenter, this staphylococcus required for the prevention of its growth in bouillon ten times as much as was required for anthrax spores, while in gelatin scarcely twice as much of the creolin is needed for staphylococcus as for anthrax spores.

In veterinary practice Dr. Frick[2] has had some cases in which severe smarting and itching have been caused by creolin. For this reason and on account of the inconvenience in transporting it on account of its bulk, he has discarded it.

Toxicity.—Behring[3] says that, while creolin in inferior to carbolic acid as an antiseptic, it may act as a dangerous poison. His law of toxicity, which extended experimental research has developed, is: to each kilo of the weight of the animal, six times the dose required to inhibit the growth of anthrax bacilli is a fatal dose to the experimental animal. This applies to carbolic acid, corrosive sublimate, and to creolin. According to Remouchamps and Sugg,[4] the fatal dose of creolin is nearly four times that of carbolic acid. Various other observers testify to

1. Op. cit. p. 151.
2. Deutsche Zeit. für Thiermed., XVII., 71. 1890.
3. Deutsche Militar. Zeit.—Centr. für Bak., V., 139. 1889.
4. Loc. cit.

the toxicity of creolin. It was at first heralded as non-poisonous, or but slightly toxic.

CRESOL.

This is a coal-tar product obtained from crude carbolic acid by fractional distillation at a temperature between 185° and 205° C.

Fränkel[1] states that there is a great difference in the disinfecting power of the distillate obtained from crude carbolic acid at different temperatures. He investigated the germicide action of the three forms,—ortho-cresol, meta-cresol, and para-cresol,—and found that meta-cresol is more efficient than either of the others. Hammer, on the other hand, found a mixture of the three cresols more efficient than either alone. Tricresol is said to be a mixture of the three forms of cresol. Of the various solutions of cresol which are on the market, Hammer[2] divides them into two classes: A. Those which become opaque when water is added to them, for example, creolin, cresolin, Little's soluble phenyl. B. Those which remain clear when water is added: lysol, solutol, and solveol. As given by Heider,[3] the quantity of cresol in each of the following preparations is: lysol, 50 per cent.; solveol, 27 per cent.; solutol, 60.4 per cent.; creolin (Pearson's), 10 per cent.

In Hammer's[4] work a 5 per cent. solution of the three cresols destroyed in five minutes the micro-organisms of green pus, cholera, and typhoid fever, and staphylococci. Anthrax spores were killed in five minutes with 10-20 per cent. solutions of crude cresol in sodium cresolate when the solution was used at a temperature of 55° C. (131° F.). The anthrax spores used were capable of resisting the influence of sublimate, 1:1000, thirty minutes, and carbolic acid, 5 per cent. 62 days.

As neutral solutions of cresol, when compared with carbolic acid, are practically unirritating and non-corrosive, and as a 0.5 per cent. solution of cresol acts as energetically as a 2 or 3, and sometimes as a 5 per cent. solution of carbolic acid, it has a great advantage over carbolic acid. Hammer thinks that cresol

1. Zeit. für Hygiene, VI., 521. 1889.
2. Archiv für Hygiene, XIV., 116. 1892.
3. Ibid., XV., 366. 1892.
4. Ibid., XII., 375-381. 1891.

is well adapted to come into general use as a disinfectant in medical and surgical practice, and to supersede carbolic acid, which is not always trustworthy.

Repeating the experiments of Hammer with anthrax spores, Heider[1] obtained results which he regards as satisfactory, but the spores were not killed in less than from 30 to 45 minutes.

Comparing the cresols with carbolic acid, Gruber[2] considers them far superior,—as 3 to 1,—when measured by the rapidity with which these preparations destroy Staphylococcus pyogenes aureus mixed with water. One advantage of cresol is that it is influenced but little by the presence of albumen. But on this point Behring[3] places some emphasis on his statement that albuminous matter affects unfavorably the action of the cresols. Only in fluids containing no albumen, he says, is cresol more efficient than carbolic acid.

For the testing of the disinfecting power of the cresols, Buttersack[4] used anthrax spores possessing a high degree of resistance. Experiments with carbolic acid were carried on, at the same time, for the purposes of comparison. To prevent the transmission of a trace of the disinfecting agent to the culture media, the spores were dried, not on the ordinary silken threads, but on little knots of glass silk, from which the disinfecting agent could be removed more readily by simple rinsings. Various preparations of cresol were tried. Besides anthrax spores, Staphylococcus pyogenes aureus and tuberculous sputum were used.

In the experiments with the staphylococcus, a 1 per cent. solution of six of the brands of cresol destroyed the infection in one minute. A 1 per cent. solution of three other preparations of cresol, and also of lysol, sterilized in three minutes. It required five minutes for one of the brands of cresol to produce the same results. One of the cresols, and also a 1 per cent. solution of carbolic acid, failed to kill the staphylococcus in ten minutes.

In the experiments with anthrax spores, a 5 per cent. solution of carbolic acid failed to kill in 50 days. A 10 per cent. solution of two of the cresols destroyed them within four days; the other nine kinds of cresol failed to disinfect in one week.

1. Archiv für Hygiene, XV., 369. 1892.
2. Ibid., XVII., 618. 1893.
3. Zeit. für Hygiene, IX., 420. 1890.
4. Arbeiten a. d. Kais. Ges., VIII., 359. 1892.

With fresh sputum containing an abundance of tubercle bacilli, a 10 per cent. solution of two of the cresols destroyed the bacilli within six hours.

The experimental work of Vahle[1] leads him to the conclusion that, on anthrax spores and the staphylococcus of suppuration, Raschig's cresol and carbolic acid are of equal disinfecting value.

The experiments of Hammerl[2] indicate that solutions of tricresol of the same percentage are superior to those of carbolic acid. A 0.5 per cent. solution of tricresol is considered equal to a 1 per cent. solution of carbolic acid, when tested on Staphylococcus pyogenes aureus. Streptococcus pyogenes longus, and brevis, and B. pyocyaneus. On anthrax spores, a 2 per cent. solution of tricresol was about equal to a 5 per cent. solution of carbolic acid, and a 2.5 per cent. solution of tricresol was distinctly superior to the 5 per cent. carbolic acid.

Excreta.—Vincent[3] states that with him cresol has shown itself to be an excellent disinfectant of fecal matter. It is also an excellent deodorant. The dose required for the sterilization of fresh diarrheal discharges is 5 to 8 parts per 1000; but the colon bacillus does not disappear before sixteen hours. In practice the requisite quantity of cresol for the disinfection of normal fecal matter is stated as 9 to 10:1000.

The typhoid bacillus in stools is destroyed in 24 hours with 6 or 7:1000. In a few cases in which the bacillus was very abundant 10:1000 was necessary. Vincent states that, in spite of its quite active power, cresol is not one of the best agents for the disinfection of typhoid stools. (See Excreta.)

On the other hand, the spirillum of cholera is very easily killed with cresol: a 3:1000 solution destroys it in less than seven hours. It is, therefore, one of the best of disinfectants, if not the best, for choleraic dejections.

Surgical.—Gruber[4] discovered that the watery solution of cresol which may be made from crude carbolic acid has an extraordinary disinfectant and antiseptic value. The solubility of the cresols varies from 0.5 per cent. to more than 2 per cent.

1. Hyg. Rundschau, III., 901. 1893.
2. Archiv für Hygiene, XXI., 198. 1891.
3. Annales de l'Inst. Past., IX., 25. 1895.
4. Archiv für Hygiene, XVII., 618. 1893.

A solution of 1 per cent. of cresol by volume made from crude carbolic acid in water destroys Staphylococcus pyogenes aureus within half a minute with certainty, and a 0.5 per cent. solution sterilized the same micro-organism in from ten to twelve minutes, and the cholera germ in from one to two minutes.

Gruber thinks that a 1 per cent. watery solution of cresol possesses great advantages in surgical antisepsis. This solution is free from the disadvantages of most of the other preparations. It is colorless, and, diluted with hard well water, it remains perfectly clear and renders neither the hands nor the instruments slippery. It is only slightly toxic. It has no benumbing or other unpleasant effect upon the skin, as occurs in using a 3 per cent. solution of carbolic acid. It causes but little smarting when applied to mucous membranes. Its cost is low. Any one can easily make the solution.

Hammerl[1] also recommends a 0.5 to 1 per cent. solution of tricresol, especially in surgical work. Hiller[2] joins also in naming the various advantages of a solution of solutol containing 0.5 per cent. of cresol which he ranks as the equivalent of a 2.5 or 3 per cent. solution of carbolic acid in surgical practice. On the other side, Vincent[3] says that solutions of cresol are less efficacious when applied to Staphylococcus pyogenes aureus and its allied micro-organisms.

Toxicity.—Grigorjeff[4] tested the comparative toxicity of tricresol and carbolic acid. The result of his experiments was the confirmation of the assertion of Delplanque that tricresol is four times less poisonous than carbolic acid.

Dr. Avery[5] made a few experiments for the purpose of testing the toxicity of tricresol on guinea-pigs. He says: "These experiments would tend to show that tricresol is a very safe antiseptic, as no such quantities as were employed here would ever be introduced into the body in the proportions that are used in antiseptic mixtures."

Professor Charteris, of Edinburgh, investigated the antiseptic value of tricresol, and he concludes that while it is a three times stronger germicide than carbolic acid it is three times less toxic.[6]

1. Archiv für Hygiene, XXI., 198. 1884.
2. Deutsche Med. Woch., XVIII., 841. 1892.
3. Annales de l'Inst. Past., IX., 8. 1895.
4. Beitr. zur patholog. Anat. u. z. Allg. Path.—Centr. für Bak., XVII., 853. 1893.
5. Medical News, LXVII., 68. 1895.
6. N. E. Med. Monthly, XIII., 604. 1894.

To secure the better solution of meta-cresols in water, Schuetz recommends the addition of five parts of alcohol to two parts of the cresols. In this way he is able to make a 2 per cent. solution of cresol in water which is clear and which remains unchanged for a long time.[1]

CRESOL SAPONATE.

This is prepared by melting a pure, soft soap in a dish on a steam-bath with an equal quantity of clear, crude carbolic acid. The resulting solution is heated until it remains clear upon cooling and dissolves in distilled water. It is a clear, Madeira-colored fluid of neutral reaction, and soluble in all proportions of water, alcohol, or glycerin. It is said to have a less disagreeable odor than that of lysol, besides being as satisfactory as the best pure lysol.[2]

DEAD BODIES. (See CORPSES.)

DISINFECTOL.

Dr. Laser,[3] referring to disinfectol, says that this is a preparation somewhat resembling creolin, which Dr. Bruno Löwenstein, of Rostock, has introduced. Beselin[4] claims that this has many advantages over other disinfecting agents in the disinfection of excreta. It contains hard soap. In his experiments, Beselin used diarrheal feces from typhoid cases, and found that a 5 per cent. emulsion of disinfectol sufficed within eighteen hours completely to disinfect an equal volume of fecal matter. A 10 per cent. emulsion was capable of disinfecting twice its volume of fecal matter.

According to Beselin, disinfectol, 5 per cent.; creolin, 12.5 per cent.; muriatic acid, 33 per cent.; carbolic acid, 5 per cent.; sublimate 2:1,000, with or without muriatic acid; are equal as regards their power of disinfecting fecal matter. He says that

1. Jahresbericht ueber die Fortschritte u. Leist. auf dem Gebiete der Hygiene., XIV., 280. 1897.
2. Centr. für Gyn.—Amer. Medico-Surg. Bulletin, VI., 423. 1893.
3. Centr. für Bak., XII., 232. 1892.
4. Centr. für Bak., VII., 364. 1890.

disinfectol, 10 per cent., exceeds all of the other agents which he enumerates for semi-fluid feces.

ELECTROLYSIS.

The two principal ways in which electricity has been applied to the disinfection of sewage are represented by the method of Mr. Webster, of England, and by that of M. Hermite, of France. In the Webster process, the electric current acts directly upon the sewage; in the Hermite process, natural or artificial sea-water is submitted to electrolysis and thereby acquires disinfecting properties. This electrolyzed sea-water is then mixed with the sewage or other matter to be disinfected.

Webster Process.—In this process, the electrodes consist of iron plates which are submerged in the sewage to be purified or disinfected. Chlorin evolved at the positive electrode combines immediately with the iron of the electrolytic plate, and a secondary transformation converts the chlorid into an oxid of iron which, as precipitant, carries down a part of the bacteria and some of the other organic matter. Experimental plants were put in for the purpose of testing this process in Salford, Crossness, and Bradford, England; but, so far as I know, no permanent works have been established for treating sewage in this way.

Dr. McLintock, Medical Officer of Health of Bradford, at a meeting of the British Medical Association in 1890, made a report on the results of the Webster process in his town, in which he stated that about 70 per cent. of the noxious and putrescible portion of the sewage is removed. He expressed the opinion that, "there is every reason for believing that, in electricity as used in Mr. Webster's patent, we have an agent capable of purifying even the worst sewage to such a degree as to render it fit to enter an ordinary stream."[1] Several of the leading authorities on public sanitation, who took part in the discussion, could not see much promise in this method.

In the Hygieneic Institute of Munich, Fermi[2] conducted a series of laboratory experiments to determine the value of the Webster process. His conclusions are that the electric current is capable of reducing the percentage of dissolved organic matter

1. British Med. Jr., II., 1890, 496.
2. Archiv für Hygiene, XIII., 207. 1891.

in sewage one half, and that precipitation with lime is cheaper and more efficient than electrolysis.

So far as I know, the most thorough investigation of this process yet made is the recent work of König and Remelé.[1] They conclude that the Webster process is nothing more than a method of chemical precipitation by means of the resulting hydroxid of iron; that there is no direct oxidation; and that processes of electrical purification are advisable only where other superior methods, land irrigation for instance, are out of the question, or where a natural power is available for the generation of electricity.

Hermite Process.—In this there is no treatment of sewage by electricity, as in the Webster process. Electricity is used only to decompose the sea-water, and this altered sea-water is then used as a disinfective agent for sewage or for other purposes. M. Hermite's complete method includes a separate system of pipes through which this electrolyzed solution is to be pumped to the places where it is needed, thus rendering it available for general domestic and municipal flushing.

In the Hermite system the positive electrode is of platinum, instead of iron as in the Webster process. In the report of the *Lancet*[2] Commission the following statement of the chemical reaction was made:

"By electrolysis of the magnesium chlorid in the sea water, magnesia and chlorin are liberated, which subsequently combine to form magnesium hypochlorite $Mg\ (OCl)^2$ and magnesium chlorid. This liquid may be regarded as the magnesian equivalent of bleaching powder solution. The magnesium hypochlorite dissociates into magnesia, which deposits on the walls and floor of the electrolyser, and free hypochlorous acid, which remains in solution.

"The Hermite solution then practically resolves itself into a dilute solution of hypochlorous acid, and may be cheaply imitated by passing carbonic acid through a solution of ordinary bleaching powder. It is admitted, however, that this 'artificial Hermite' gave in bacteriological examination 'varying results, and could not be depended on to exert constantly an equivalent

1. Archiv für Hygiene, XXVIII., 185. 1897.
2. Lancet, 1., 1894, 1321.

action to the Hermite solution.' Chemically, however, the two solutions exhibited very close resemblance."

While the Hermite system was on trial in Worthing, Dr. Kelly,[1] Medical Officer of Health for West Sussex, investigated the process. Samples of the Hermite solution examined by him contained from 0.22 to 0.75 gram of chlorin per litre, but usually there was from 0.44 to 0.51 gram. M. Hermite claims that 0.30 gram suffices. Samples of sewage treated with the Hermite solution were examined by Dr. Klein. Ordinary sewage contains from 3,000,000 to 10,000,000 bacteria. These treated samples contained from 800 to 1,000. While there was a great diminution in the bacterial contents, Dr. Klein found that the solution failed to destroy even all of the sporeless bacteria. While the printed pamphlet descriptive of the process claims that the Hermite solution "instantly" destroys the bacteria of sewage when the two liquids are mixed, Klein found that, when bouillon cultures of typhoid bacillus, cholera vibrio, or colon bacterium were mixed half-and-half with the disinfectant solution, none of the cultures were sterilized in twenty minutes. While Dr. Klein found the Hermite solution itself to be sterile, its disinfective action was small when added to sewage in much larger proportion than occurs in practice. Dr. Kelly concludes his report with: "Since there is no instantaneous decomposition of fecal matter, and no sterilization of sewage, I am of opinion that the process, as far as the late trials have gone, has therefore failed to produce the results which are claimed for it by its inventor."

The Hermite process was first tested in Havre, in 1893, and soon afterward in Lorient, France, and Worthing, and Ipswich, England. As stated by König and Remelé,[2] the commission which was sent to Havre by the Imperial Board of Health of Germany, and one sent from Paris by the Central Council of Hygiene, both reported adversely. König and Remelé express the opinion that "the Hermite process has not as yet been shown to be practical, and appears to have been given up everywhere." Their conclusions, based upon their own experiments, are that processes of electrical purification are advisable only where other

1. Public Health, VI., 261. 1894. London.
2. Archiv für Hygiene, XXVIII., 185. 1897.

superior methods are out of the question, or where a natural power is available for the generation of electricity.

Woolf Process.—This is also a process of electrolyzing sea-water, or a solution of salt in water, for the purpose of disinfecting sewage, water supplies, etc. The exposed surfaces of the positive electrodes are of platinum, as in the Hermite process, and the chemical transformation wrought in saline solutions subjected to its electric current are undoubtedly identical with those in the Hermite process. The testimonials to the efficacy of "electrozone" and Hermite solution indicate a reawakening to the fact that solutions of the hypochlorites, or Labarraque's solution, though old, are efficient disinfectant agents, as the report of the Committee of the American Public Health Association indicated. There is nothing to show that these solutions have any properties, disinfective or otherwise useful, further than those of the hypochlorite solutions prepared in the older ways.

The first official test of this process was made by the Board of Health of New York City, in 1893, at Brewsters. The sewage of this village polluted the Croton water supply. A plant was erected and "electrozone" was run into the sewers with the sewage. The results were investigated by Mr. Martin, the chemist of the Board. When certain quantities of electrozone were run into the sewers, the sewage thus treated was said to have become odorless and almost sterile, after it had been filtered; and, when to the sewage in a 1000-gallon tank, salt had been added until the sewage contained 2 per cent. of sodium chlorid, and the electric current was turned on until the fluid contained 40 grams of hypochlorite to the gallon, "the bacteria were reduced in an hour and a half from 10,000,000 per cubic centimetre to none."[1]

In 1894, Riker Island, which had been used as the dumping-ground for the garbage of New York City until it had become a serious nuisance, was effectively disinfected by the application of electrolyzed sea-water liberally and for a long time applied with hose and nozzle.

These results, reported to the Board of Health of New York, are remarkable in view of some of the statements of those who

1. Engineering Record, XXIX., 110. 1894.

have investigated the disinfecting claims of electrolyzed sea-water in Europe, and of the conditions which have been prescribed as prerequisites to successful disinfection with the hypochlorites. One of these prerequisites is that the quantity of hypochlorite in a solution of chlorid of lime or hypochlorite of sodium shall be quite largely in excess of the organic matter to be acted upon, else the hypochlorite, while acting upon the organic matter, is itself destroyed before all of the infectious material is sterilized. Klein found that, mixed half-and-half with sewage or cultures of the cholera or typhoid germ, sterilization was never effected. In Hermite's method comparatively large quantities of the electrolyzed sea-water were allowed to act repeatedly upon the fecal matter in sewage, in small enclosed spaces, nevertheless, under these favorable conditions the disintegration of masses of fecal matter was slow and incomplete, and sterilization was not effected. It is stated that, at Brewsters, 1 part of hypochlorite to 100,000 of water was used to sterilize the sewage.[1]

Dr. W. J. Gillespie, Assistant Bacteriologist of the Bureau of Health of Philadelphia, carried out a series of experiments at the request of the Board with the view of determining the value of solutions of hypochlorites made by the action of the electric current. His report states:

"An excess, or about 8 cc., of hypochlorites added to 5 cc. of a 4-day-old spore of anthrax in bouillon destroys them completely in less than five minutes.

"From 1 to 2 cc. of hypochlorites added to 10 cc. of a bouillon culture of diphtheria bacilli, entirely destroys them in less than twenty-four hours.

"An excess, or about 8 cc., of hypochlorites added to 5 cc. of a 72-hour bouillon culture of diphtheria bacilli, destroys them completely in less than five minutes.

"From 1 to 2 cc. of hypochlorites added to 10 cc. of an active culture of Staphylococcus pyogenes aureus, entirely destroys them in a very short time.

"About 2 cc. of hypochlorites added to 10 cc. of urine preserve it indefinitely, free from decomposition or odor.

"These experiments proved hypochlorite to be a powerful germicide, since it kills the most resistant of all organisms (anthrax spores) in five minutes or less.

1. Electrical Engineer, XVIII., 101. 1894.

"The cheapness of the material, and the rapidity and ease with which large quantities can be made, recommended it to me, and at the same time thinking that if its value as a disinfectant, germicide and antiseptic was all that was claimed for it, we had an ideal article—cheap, efficient and non-poisonous. As a municipal germicide and disinfectant it cannot be surpassed."[1]

Electrical Purification of Water.—In a paper with this title, Professor Drown,[2] of the Massachusetts Institute of Technology, says:

"The so-called electrical purification of water, by treating it with an electrolyzed solution of salt, is thus seen to be simply a process of disinfection by sodium hypochlorite; electricity, as such, has nothing to do with it. There is nothing peculiar in the sodium hypochlorite produced by electrolysis; it has no different properties from that made by the ordinary process of passing chlorin into a solution of caustic soda. That other compounds are formed in small amount by the action of chlorin on caustic soda is true, but it has not been shown, nor is it probable, that any one of them has as potent germicidal power as the hypochlorite.

"It is unfortunate, I think, that the advocates of this system of purification of water and sewage are not content to attribute the purifying action of the electrolyzed solution of salt solely to the hypochlorite formed. There is nothing gained by calling it 'electrozone' or an 'electro-saline solution,' for there is nothing mysterious about its action, as these terms would lead one to suppose. Nor is it proper to speak of this system of purification in any sense as an 'electrical' one.

"Finally, is it desirable in any case to treat a city's water supply with a powerful disinfectant like the hypochlorites? When the question is put in this bald form I cannot think it will receive the approval of engineers and sanitarians."

A review of the available evidence appears to justify the doubt whether electrolysis, or such products of electrolysis as have been under consideration, offer an efficient method of purifying sewage so as to make safe its admission into sources of public water supply. For some purposes, however, and in some places, it seems to have been shown that hypochlorite solutions pre-

1. From a copy of the report received through the courtesy of Dr. Gillespie.
2. Jr. of the N. E. Water Works Assoc., VIII., 185. 1894.

pared under the influence of the electric current, may be used with advantage. (See Ozone.)

Chlorin Manufactured by Electrolysis.—In the paper to which reference has already been made, Professor Drown says: "When a solution of salt (chlorid of sodium) is decomposed by electricity, we have sodium liberated at one pole and chlorin at the other. The sodium is immediately oxidized and combines with the water present, and a solution of caustic soda results. By suitable mechanical contrivances the chlorin gas may be conducted away from the other pole as fast as liberated and collected as such. This method of making caustic soda, it may be said incidentally, is yet more or less in an experimental stage, but it seems not unlikely that the electrolytic production of caustic soda from common salt may become one of the world's great industries."

The fuller elaboration of the idea of the municipal production of two very effective disinfecting agents,—caustic soda and chlorin gas,—by those cities which own an electric lighting plant, is given in a paper read before the Liverpool Polytechnic Society, by James Hargreaves, F. C. S.[1] The following is an abstract of the paper:

"Of all the chemical agents proposed for disinfection, the most effective, and at the same time the least injurious, is chlorin. The usual method of using it has been in the form of chlorid of lime or bleaching powder. In this form it adds to the alkalinity of the sewage, which is not desirable. It also adds to the solid matter. It has little or no action upon the walls and crown of the sewer above the level at which the liquid sewage flows, and its power of exterminating the zymotic 'colonies' on the walls and in the cracks and chinks of the sewers is almost nil. By passing chlorin gas directly into the sewers the sources of infection are at once reached, and the germs exterminated. When this is once thoroughly done there can be no further propagation, except by replanting with fresh germs from other sources.

"The chief difficulty in the application of chlorin is its first cost. At present the most practical means of obtaining it is in the form of bleaching powder, in which the actual chlorin costs

1. The Sanitary Record, XVII., 664. 1896.

£17 to £20 per ton at lately prevailing prices. If made fully effective by liberation in the form of gas it would cost 50 per cent. additional for the acid used to liberate it. But the problem is considerably modified when it can be produced in its most active form for fewer shillings than the pounds it now costs. In view of its more extended application it becomes of importance to examine its properties.

"Chlorin, being gaseous, readily diffuses into cavities and openings which could not otherwise be reached, and also ensures that the zymotic growths will be exposed to its action, which is only very partially the case when bleaching powder is used. Its being 2½ times as heavy as air ensures that it will be in greater quantity near the floor of the sewer, and so dispose of rats and other vermin. Being soluble in about half its volume of water further ensures that the germ life in the sewage itself will also be attacked, and that by discontinuing the supply of chlorine for a short time workmen will be able to enter the sewers without injury or inconvenience.

"What will the chlorin cost? The system of producing it, which I submit to your attention, employs the electric current, and is most easily applied where electric lighting is in use, and more especially where a corporation produces its own current. The electric plant is standing for more than half its time, so there is power enough to produce all the chlorin needed for the sewers many times over.

"It is difficult to state precisely the cost of the power needed; for every electrical engineer has his own notions on that subject. Hence I prefer to give the physical data, and leave the engineer to work out the cost for himself. 600,000 ampère hours with an electro-motive force of 3.5 volts, or 2,100 units, will decompose one ton of salt per hour, with ample allowance for contingencies. As there is no special outlay for generating plant, there is no need—except for book-keeping purposes—to charge interest on that. The only extra outlay for generation current is for the fuel and lubricants consumed, firemen's wages, and the quota for maintenance. With good engines and anything like a favorable price for fuel this should not cost more than ¼d. per unit, or 43s. 9d. per ton of salt decomposed. With proper arrangements it can be done for less, but I give this as

the highest cost that can be quoted where fairly good engines are used, and the other conditions are not exceptional. Where good effective heat engines are used, one horse-power can be obtained by the consumption of 1 pound of coal or even less per hour. Allowing 10 per cent. for moisture and impurities in the salt, and for the salt remaining undecomposed in the alkali, the salt costing 12s. per ton, the cost of one ton of pure salt actually decomposed is 13s. 3d. One ton more fuel to produce steam and concentrate soda liquor is ample.

"The alkali would make 44 cwt. of soda crystals, for which there is always a local market. If sold at ¼d. per pound, or say 2s. per cwt., the value is £4 8s. The account for power and material is:

Motive power	£2	3	9
Salt	0	13	3
One ton small coal	0	8	0
	£3	5	0

"Soda crystals sold, £4 8s, or a margin of 23s. to pay for labour, and interest, and maintenance of electrolytic plant. What this would amount to depends on the scale upon which the work is done. With a small installation, the above margin would be exceeded, while with a large one, such as one might expect to be erected for the sewage flowing to Barking Creek, the chlorin should cost less than nothing.

"The chlorin from one ton of salt weighs 12 cwt., and in oxidizing or disinfecting power is equal to 33 cwt. of bleaching powder, which at present prices would cost £11 at makers' works.

"The problem of sewage utilisation becomes considerably simplified when chlorin can be obtained at a practicable price. The perfect sterilisation of sewage gets rid of the danger of zymotic infection amongst the animals fed on the products raised from sewage manures, whether in the liquid or precipitated form. Chlorin also affords the means of getting rid of those disgusting smells which render sewage farms so undesirable in vicinity of human habitation. The utilisation of sewage is a problem that somebody must solve some day. We cannot go on for ever throwing the elements of nutrition into the sea, and converting our watercourses into open sewers. Sewage is

not pleasant either to smell or look at, but we must remember that it contains the elements of all nutriment. It is only a question of re-arranging its molecules to convert it into strawberries and cream. It was once thought to be a fine piece of sarcasm to charge one's political opponents with having a 'policy of sewage.' My opinion is that those who thoroughly solve the sewage problem will have done more for their country and their race than has been done by all the party politicians that have ever existed.

"The distribution of the chlorin to the different parts of the district to be served is a matter that may be left to the engineer, and I will only state that as a general rule the bulk of the chlorin will be required at a point between the general confluence of the great mass of sewers and the final out fall. In the event of its being needed in or near centres of infection, it is a simple matter to compress the gas into the fluid state, which only requires about four atmospheres of pressure. In this form it can be delivered at any desired point. Again, it may be converted into ordinary bleaching powder or into bleaching liquor, for spreading upon the ground, or in other cases where free chlorin is not desirable. In the gaseous state it is an immediate and effective exterminator of rats and other vermin by introduction into their underground runs.

"In conclusion, I may point out another method by which the now unused day power may be employed and some profit made for the reduction of rates and taxes. Many users of bleaching powder, such as paper-makers, bleachers, etc., have their works, at or near towns, lighted by electricity. A good profit could be made by supplying bleaching liquor or bleaching powder and alkali for local use. The most costly part of the plant is already erected, but doing nothing for more than half its time, and it is well worth the expenditure of a little ingenuity to try to find a profitable use for it, more especially if a few factors of the 'unemployed problem' could be solved at the same time."

ESSENTIAL OILS.

Some of the essential oils tested by Koch[1] were found to have a marked antiseptic action, differing much in degree. While it required 1:5,000 of oil of cloves to check the development of anthrax bacilli, 1:33,000 of oil of peppermint, or 1:75,000 of turpentine-oil, sufficed to show a restraining influence.

Oil of cinnamon, according to Behring,[2] is about three times as potent a germicide in blood serum or bouillon as carbolic acid. Thymol and eucalyptol are about four times weaker than carbolic acid.

The germicide qualities of the vapor arising from the essential oils were investigated by Omeltschenko,[3] of Kiev. His conclusions are, in part, as follows: Among the essential oils investigated by him, oil of cinnamon stands first in its germicide power, and after it in the order of their antiseptic action, are oil of fennel, lavender, cloves, thyme, peppermint, anise, eucalyptus globulus, etc.

Bacteria in a dried condition are destroyed less rapidly than when in a normal condition. Anthrax spores were not destroyed by the action of these oils, but their vitality was distinctly weakened. The protoplasm of bacteria suffers a chemical change while under the action of the vapors of these oils so that its capability of taking anilin stains is lessened or destroyed, and the degree of the loss of its staining may be taken as an indication of the bactericide influence of the vapor. The popular use of the vapor of these essential oils has a rational basis.

Onimus[4] determined that the oxidation products formed when solutions of essential oils in alcohol, particularly of oil of thyme, are passed over glowing platinum sponge, are capable of destroying the bacillus of tuberculosis. It is, however, doubtful whether the essential oils as such had anything to do with the germicide action observed in the experiments of Onimus. It was more likely due to products analagous to formaldehyde, or possibly to ozonization.

1. Mittheil. a. d. Kais. Ges. I., 271. 1881.
2. Zeit. für Hygiene, IX., 428. 1890.
3. Centr. für Bak., IX., 813. 1891.
4. Le Bul. Med., 1890.—Centr. für Bak., IX., 739. 1891.

EUCALINE.

This is an American preparation for sale by Theodore Metcalf Co., which that firm claims is the best of the common disinfectants. One gallon with 100 gallons of water gives a mixture for large usage, and one teaspoonful to the pint of water is the usual domestic mixture employed. It is stated with regard to its chemical composition, that it is a residue of a number of manufacturing operations in which benzol and some of the coal-tar products are produced. It contains naphthalin, hydronaphthol, resorcin, and beta-naphthol. I do not know that its germicidal capabilities have been determined.

EXCRETA.

The disinfection of excreta may be considered under two headings:

Fresh Excreta, or Its Disinfection in the Sick-Room.—It is too often forgotten that time is an important element in disinfection, but for fresh excreta, disinfecting agents should be chosen that do not require too much time. Another important consideration is that the disinfecting solution must be brought into intimate relation with the masses and particles of fecal matter by stirring or otherwise.

The 5 per cent. carbolic acid solution is widely used for the disinfection of excreta, and should, undoubtedly, be considered efficient. The preponderance of opinion among investigators, however, seems to be that some of the other coal-tar preparations,—lysol, cresol, solutol—are more rapidly effective.

Lime-wash, or milk of lime has been much used lately for the disinfection of excreta, but it is apparently less rapid in its action than chlorid of lime, carbolic acid, lysol, and some of the other preparations of cresol. Chlorid of lime, as determined by Nissen, destroys typhoid and cholera germs in stools much more rapidly than does caustic lime. The work of Sternberg and that of Vincent corroborate that of Nissen. On the other hand, Richard and Chantemesse found that 20 per cent. milk of lime, as recommended by Pfuhl, destroyed typhoid bacillus in stools in half an hour, while an hour was required for their disinfection with a 5 per cent. solution of chlorid of lime.

Vincent, Schottelieus, Pohl, and others have found lysol superior to carbolic acid for the disinfection of excreta.

With Vincent cresol was an excellent disinfectant for fecal matter, and also an excellent deodorant. He states that in spite of its quite active power, it is not one of the best disinfectants for the disinfection of typhoid fever stools, but the spirillum of cholera is very easily killed with cresol.

The investigations of Buttersack, Hueppe, Heider, and others indicate that solutol is a very suitable disinfectant for the rapid disinfection of excreta. Some of the authors state that it penetrates into the interior of organic matter more rapidly than lysol and carbolic acid, and is more rapid in its action. It is also a good deodorant.

Sternberg, Gerloczy, and Vincent recommend very highly solutions of sulphate of copper as very efficient disinfectants for excreta, but both milk of lime and solution of chlorid of lime are cheaper, and the latter probably acts with greater rapidity.

The conclusion of most investigators has been that mercuric chlorid is unsuitable for the disinfection of excreta. Foote found that the simple solution of mercuric chlorid was inefficient, but with the addition of sodium chlorid, it was the most efficient disinfectant tested by him. Uffelmann also, while finding the simple solution inefficient, found that a 1:500 solution with hydrochloric acid destroyed, with certainty, all germs in twenty-four hours. The results obtained by various investigators in the application of corrosive sublimate to the disinfection of excreta are too discrepant to encourage its use for that purpose.

Gerloczy, while recommending sulphate of copper highly for the disinfection of excreta, says that a still more efficient method for the rapid disinfection of stools in the sick-room, is pouring over them three times their bulk of hot lye,—one part of ashes to two of water.

Wilchur[1] states that a sure method of disinfecting cholera stools is pouring upon them four times their bulk of boiling water. For the disinfection of stools in the sick-room generally, it appears that we may safely advise a 5 per cent. solution of carbolic acid, a 3 per cent. solution of lysol or solutol, the 5 per

1. Sanitary News, XII., 83. 1888.

cent. solution of chlorid of lime, or the 20 per cent. milk of lime. When either of the two last is used, its quantity should be largely in excess of the bulk of the stool, and ample time should be given for the action of the disinfectant.

Ascoli is authority for the statement that solutions of formaldehyde act readily and efficiently in the disinfection of fecal matter, and Walter corroborates this. Both of these experimenters, as well as others, vouch for its rapid deodorizing action.

Excreta in Bulk.—For the disinfection of excreta in bulk, as in privy vaults, milk of lime prepared as described under "Lime," or chlorid of lime, preferably in solution, are to be recommended for their cheapness as well as for their efficiency when used in liberal quantities.

The disinfection of excreta in bulk with the phenols is too costly; the experiments with saprol, however, indicate that privy vaults of tight construction may be successfully disinfected with it, and this preparation is said to be cheap.

Creolin, Little's soluble phenyle, lysol, saprol, solutol, and crude Carbolic acid are all good deodorants.

Pulverized peat has been much used in the countries of Europe, as an application to excreta in vaults; but, alone, it has no trustworthy disinfecting properties.

FERRIC SULPHATE.

In a recent paper on the value of ferric sulphate as a disinfectant Riecke[1] used a fine, dirty-white powder which, according to the manufacturers, contains about 70 per cent. of ferric sulphate readily soluble in water, a few per cent. of ferrous sulphate, and from 4 to 5 per cent. of free sulphuric acid. He says that it is probable that its germicidal properties are due to both the free sulphuric acid and to the metal combination.

He cites the results obtained by various experimenters as an indication of the germicidal action of the several constituents of the salt. According to Koch, anthrax spores were killed in from ten to twenty days when exposed to 1 per cent. of sulphuric acid. Kitasato found that the growth of typhoid bacillus was inhibited with 0.057 per cent., and from 0.073 to 0.08 per

1. Zeit. für Hygiene, XXIV., 308. 1897.

cent. destroyed it. The results obtained by Koch with chlorid of iron and the common sulphate of iron were unfavorable. Fromme found that metallic iron, at the instant of oxidation, has a marked germicidal action. Löffler found chlorid of iron to be an efficient disinfectant for the bacillus of diphtheria, and made it a constituent of the preparation for his local treatment.

The experiments of Riecke indicate that typhoid cultures in bouillon were sterilized in one minute with 5 per cent. of ferric sulphate. A 5 per cent. solution of ferric sulphate added in equal quantities to typhoid bacillus and to cholera bacillus in acid urine, in alkaline urine, in acid feces, in alkaline feces, in acid mixture of urine and feces, invariably destroyed typhoid and cholera germs in one minute. The period of observation was from eight to twenty-one days, and controls were used in all cases. These germs are thus killed with certainty with a 2.5 per cent. solution in one minute. He states that it is also a good deodorant. He learned, also, that ferric sulphate is better than acids as an addition to pulverized peat. The price of ferric sulphate, he states, is, in Germany, 5 M. per 100 kilograms.

FERROUS SULPHATE (SULPHATE OF IRON.)

Sulphate of iron was formerly much used as a disinfectant, but its germicidal action is now known to be very slight indeed. Sternberg[1] found that a saturated solution failed to destroy the growing power of any of the test-organisms. In Koch's[2] experiments, anthrax spores remained in a 5 per cent. solution six days without harm.

Applied to the disinfection of excreta, Vincent[3] found that even when the mixture is 200 or 300 to 1,000, sulphate of iron fails to accomplish only a very incomplete disinfection of the material, even after forty-three hours. He ranks it below all other disinfectants tested by him.

As a deodorant, sulphate of iron is still recommended by some persons who concede its worthlessness as a disinfectant. But Foote[4] states that, in his experiments, it showed itself totally

1. Tr. Amer. Pbblic Health Assoc., XI., 225. 1885.
2. Mittheil. a. d. Kais. Ges., I., 234. 1881.
3. Annales de l'Inst. Past., IX., 9. 1895.
4. Amer. Jr. Med. Sciences, XCVIII., 329. 1889.

inefficient, both as a disinfectant, and as a deodorizer, and that there is no rational basis for its use for these purposes. He further says that it developed an odor considerably more disagreeable than that of the mixture of feces with sterilized water, and that the odor did not lessen in any appreciable degree in seventy-two hours when the flask was emptied.

Rideal[1] speaks of some of the undesirable qualities of sulphate of iron when used as a deodorant:

"Virchow has pointed out one of the inconveniences of iron salts. The volatile fatty acids, butyric, valeric, etc., which cause a part of the offensive odor of putrefaction, are commonly combined with ammonia. When iron salts are added, the fatty acids are set free or turned into unstable iron compounds, so that the immediate effect of the projection of sulphate of iron into latrines is often an augmentation of the fetor; this soon decreases, but usually reappears after a time. The same result would accrue on adding almost any acid or acid salt, and thus, as well as for other reasons, it is necessary to supplement the use of an acid or treatment with an iron salt by lime. Lake proposes iron salt, then lime, then filter; Lockwood, iron salt, then hot milk of lime.

"Deposits of sulphide of iron in sewers may be a source of danger, since they are liable to produce sulphuretted hydrogen on the influx of any acid liquid. An oxidizing disinfectant like chlorin would, however, convert it into a sulphate and allow of its removal. All reducing disinfectants are open to the following objections: (1.) they permit the reduced organic matters to be oxidized again by the air; (2.) they are themselves in great part at first wasted by the free oxygen of the air and the water; (3.) unless kept out of contact with air they lose strength more or less rapidly by absorbing oxygen; (4.) the anaerobic bacteria are mostly reducing in their action and flourish readily in surroundings deprived of oxygen, whereas free oxygen is capable itself of killing them and destroying their food."

Occasional reference to Rabot's method is noticed, which is recommended for the disinfection and deodorization of sewers, or mud, or ooze. (See Mud). It consists in the use of 500 grams of sulphate of iron followed by 1 kilogram of caustic lime, to each cubic metre of material to be treated.

1. Disinfection and Disinfectants, p. 118. 1895. London.

FLOORS.

While under "Walls" it is stated that in typhoid fever the possibility of their infection is very slight, it may be assumed that the floors are infected. After all cases of infectious diseases, efficient methods of disinfecting the floors of the sick-room are required. It should be remembered that infection consists of particulate matter, which, like all matter, obeys the law of gravitation. The floor is, of course, the most extended horizontal surface in the room and receives a large part of the infectious dust or other matter. In disinfection processes, the cracks in the floors should receive especial attention, as recurring cases in outbreaks of infectious diseases have been traced to neglect of this injunction.

A rule of the Department of Health of Chicago is that floors of sick-rooms shall not be dry-swept. They must first be sprinkled thoroughly with tea leaves or sawdust wet with a strong disinfectant; the sweepings being burned immediately. They should then be wiped with a cloth wrung out of the disinfecting solution. The recommendations of the Paris Commission[1] are that floors shall be washed with a solution of corrosive sublimate. If there is a carpet, it shall be cleansed with a brush dipped in the same solution. The practice in Berlin, according to Behring,[2] is that floors shall have two washings in a 5 per cent. solution of carbolic acid, and if they are very dirty they shall be scrubbed with hot soap and water.

Professor Löffler[3] prefers sublimate to carbolic acid, and regrets that it is not used more. The danger from the former is very slight, and the smell of the latter lasts for weeks and is very unpleasant to many persons. He even thinks that the trace of mercuric chlorid left in the air of a room may be prophylactic, and relates a corroborative experiment.

Rosenberg recommends the thorough washing of floors with a solution of 100 cc. of holzin to ten litres of water before the formaldehyde apparatus is set in operation. His idea is that the liquid disinfecting solution softens any germs that may be present, for instance, those of tuberculous sputum, and thus facilitates their destruction with the gas.

1. Revue D'Hygiene, XVIII., 958. 1896.
2. Bekampfung der Infectionskrankheiten, I., 428. 1894.
3. Deutsche Viert. für öff. Ges., XXIII., 149. 1891.

For floors which would not be injured by alkaline applications, a 3 or 4 per cent. solution of lysol would be an efficient wash; for floors in natural finish, spraying or washing with a formaldehyde solution would constitute an unobjectionable and probably efficient method.

There should be no carpet upon the floor of the infectious sick-room. If, however, there has been one, it should be disinfected by steam, if practicable. Formaldehyde cannot be considered an entirely trustworthy agent for the disinfection of carpets in place. Stood in loose rolls in a small cabinet or disinfecting chamber, with impermeable walls, formaldehyde would, undoubtedly, prove efficient.

Carpets that have been upon the floor of the sick-room of consumptives would better be burned by the owner when steam disinfecton is not available.

Carpets were completely sterilized by Stahl by spraying them with a 5 per cent. and 2 per cent. solution of formalin, and maintaining the exposure to the vapor from fifteen to thirty minutes.[1]

In Paris carpets are taken up and sprayed plentifully on both sides with a 1:500 solution of mercuric chlorid.[2]

FORMALDEHYDE.

About six years ago the interest of the compiler of these notes was temporarily aroused by occasional journalistic references to formalin as a disinfectant, but an adverse report came to hand some time afterward which indicated that its germicidal efficacy had been overrated. The appearance in a French journal of 1895, of a notable paper by Cambier and Brochet[3] and another by Trillat[4] on the disinfection of rooms with formaldehyde gas, showed very clearly that this agent possesses disinfecting capabilities which deserved further study. At the Denver meeting of the American Public Health Association in the same year, in a discussion on railway hygiene, Dr. J. J. Kinyoun referred to experiments which had been begun in the bacteriological laboratory of the Marine Hospital Service. The experiments, so far

1. Quoted from Walter. Zeit. für Hygiene, XXI., 476. 1896.
2. Annales de Micrographie, VIII., 285. 1896.
3. Revue D'Hygiene, XVII., 120. 1895.
4. Ib., XVII., 714. 1895.

as they had then been carried, indicated that formaldehyde gas would prove to be a valuable agent for the disinfection of cars, rooms, etc. At that time the price of formalin, or solution of formaldehyde, was prohibitive of its general use as a source of formaldehyde gas, and no lamps or other apparatus were available for its generation directly from methyl alcohol. In the autumn of 1895, Professor F. C. Robinson was requested by the State Board of Health of Maine to undertake an extended series of experiments for the purpose of determining the real value of formaldehyde in practical disinfection, and to devise, if practicable, a lamp capable of evolving large quantities of the gas in a short space of time. Many preliminary trials were made with lamps modeled after those which had been used by European investigators,—with incandescent cylinders or spiral coils of platinum or other material. The quantities of formaldehyde delivered by any of the lamps of this type were found to be wholly inadequate in the disinfection of rooms. The platinization of asbestos and perforated horizontal disks of that material for the incandescent surface was a happy thought which made it practicable to generate formaldehyde gas rapidly and in large quantities and to popularize its application to the disinfection of rooms.

Germicidal and Antiseptic Value.—Many of the earlier experiments with formaldehyde were made with lamps that furnished comparatively small quantities of the gas. The later workers have, however, almost unanimously fixed the fact that formaldehyde has remarkable disinfectant and antiseptic powers. The only questions at present are the methods of using and the limitations of this process.

According to Blum,[1] formaldehyde, even when strongly concentrated, acts only slowly in destroying the vitality of microorganisms. Weak solutions, however, suffice to prevent fermentation with gradual destruction of the bacteria. Vanderlinder and Burk's[2] experiments convinced them that a 5 per cent. solution of formalin (2 per cent. of formaldehyde) has no very pronounced action on bacillus typhosus, B. coli, streptococci, and staphylococcus. Strehl,[3] in his experiments, found

1. Münchener Med. Woch.—Centr. für Bak., XIV., 503. 1893.
2. Arch. de Med. Experim., VII., 76. 1895.
3. Centr. für Bak. XIX., 785. 1895.

that 50 cc. of Schering's formalin in a tight chest of one fourth cubic metre capacity did not suffice to sterilize silken threads with anthrax spores and staphylococcus in twenty-four hours at 20° C. These results are the only positively unfavorable ones which have been found in an examination of the work of fifty or more investigators.

The results of the experiments of Philipp,[1] in the sterilization of the dust in dusty rooms, have assured him that formaldehyde vapor by far exceeds in value all other gaseous disinfecting agents. Formaldehyde, according to Aronson,[2] when added in the proportion of 1 part to 20,000 of bouillon which contained an abundance of typhoid bacilli, preserved it in a sterile condition. The action upon Staphylococcus pyogenes aureus was almost exactly the same. In his experiments, Ascoli[3] used bits of blotting paper previously sterilized and then impregnated with an emulsion of the bacteria. Precautions were taken against carrying over traces of the antiseptic agent, and the culture tubes were kept under observation at a temperature of 37° C. for at least ten days. With formalin, anthrax bacilli were killed in fifteen minutes with a 10 per cent. solution, and anthrax spores capable of withstanding action of steam at 100° C. twelve minutes, were destroyed in less than five hours with a 10 per cent. solution. With a 5 per cent. solution, diphtheria bacillus was destroyed in ten minutes, anthrax bacillus in fifteen minutes, Staphylococcus aureus in thirty minutes, and anthrax spores in five hours. In his experiments with 1 part of formaldehyde gas in 100 parts of air, pneumococcus was killed in fifteen minutes, Staphylococcus aureus in forty-five minutes, and anthrax spores in forty-five minutes. The organisms were confined in flasks of one litre and a half capacity. Lehmann[4] also found that even anthrax spores were destroyed with formaldehyde gas, the time of exposure being twenty-four hours. In the opinion of Rosenberg,[5] formaldehyde is tenfold more efficient than corrosive sublimate as a disinfectant. Trillat[6] says that formaldehyde is the most powerful gaseous disinfectant

1. Münchener Med. Woch.—Centr. für Bak., XVII., 499. 1895.
2. Berlin. klin. Woch.—Centr. für Bak., XII., 406. 1892.
3. Centr. für Bak., XVII., 849. 1895.
4. Münchener Med. Woch.—Giornale della Reale Soc. Ital. D'Ig., XVI., 151. 1894.
5. Zeit. für Hygiene, XXIV., 488. 1897.
6. La Formaldehyde, p. 127. 1896.

known. In Slater and Rideal's[1] experiments, the growth of vigorous cultures was absolutely inhibited, with most of the bacteria, by 1:20,000 of formaldehyde. Staphylococcus pyogenes aureus, however, required 1:5,000. According to Walter,[2] a formalin solution of 1:10,000 prevents absolutely the growth of anthrax spores, cholera, typhoid, and diphtheria bacilli, and Staphylococcus pyogenes aureus. He observes that his results concur with those of most other observers, reminding them, at the same time, that 1:10,000 formalin solution contains one to 25,000 formaldehyde gas.

The results of the experimental work, to which reference is made under other subheadings, make a more extended presentation of this question unnecessary here.

Besides its antiseptic and disinfectant properties, formaldehyde appears to be an efficient deodorant. Trillat states that it is possessed of great deodorizing powers. Aronson[3] says that formaldehyde combines readily with nearly all ill-smelling compounds, as hydrogen-sulphid, mercaptan, and ammonia, forming others that are non-offensive. Ascoli reports that formaldehyde has the advantage of being an energetic deodorizing agent. It does not merely cover smell, but really destroys it. His experiments indicate to him that solutions of formalin may be trusted to disinfect the discharges from cholera and typhoid cases.

Walter[4] states also that fecal matter is almost instantaneously deodorized with 1 per cent. of formalin, and is sterilized in ten minutes with 10 per cent. solutions.

Available Sources.—One of the sources of formic aldehyde, or formaldehyde gas, is "formalin,"' a 40 per cent. aqueous solution put up by a German firm, but which may more economically be bought under the name of Solution of Formaldehyde as it is put up in this country. To prevent polymerization when this solution is evaporated, Trillat adds to it a solution of calcium chlorid and gives the mixture the name of "formochloral." A second method of obtaining the gas has been by the oxidization of wood spirit or methyl-alcohol by passing it over glowing platinum or other suitable metallic surfaces. The name "holzin"

1. Lancet, I., 1894, 1004.
2. Zeit. für Hygiene, XXI., 421. 1896.
3. Zeit. für Hygiene, XXV., 168. 1897.
4. Zeit. für Hygiene, XXI., 148. 1896.

has been given by Oppermann to a 60 per cent. solution of formaldehyde in methyl-alcohol. Adding to this solution a small quantity of menthol to lessen its irritating quality, Rosenberg[1] calls it "holzinol." Another source is formaldehyde in its solid form,—trioxymethylin, paraformaldehyde, or polymerized formaldehyde. A trade name is "paraform."

Formaldehyde Generators.—In the evaporation of the solution of formaldehyde in the ordinary ways, there is a considerable loss due to polymerization. A residue consisting of formaldehyde in its solid, or polymerized form, is left. The French investigators sought to prevent this by adding a solution of calcium chlorid to the formaldehyde solution. Trillat invented an apparatus which he calls an autoclave for the vaporization of this formochloral, as he calls the solution of formaldehyde with calcium chlorid. It is supplied with a set of valves which automatically let the formaldehyde vapor escape when the pressure in its interior has reached that of three or three and one half atmospheres. The gas is conducted into the room from the autoclave by means of a small brass pipe which usually enters the room through a keyhole. The disadvantages of this apparatus and others patterned after it are: first, its high cost; second, some danger of explosion due to the non-working of the valves, or the corrosion and obstruction of the metal pipe which conducts the gas into the room; and, third, the want of uniformity in the quantity of gas delivered in a given time. This last objection was shown very plainly by the experiments of Professor Robinson[2] with a generator patterned after the French apparatus. The apparatus in each test was run one hour with the following results: first, 500 cc. per hour; second, 320 cc.; third, 380 cc.; fourth, 130 cc.; fifth, 350 cc. The sixth experiment was interrupted after the apparatus had been running one half hour, when it was found that, practically, no formaldehyde had been injected into the room. The advantages claimed for the autoclave and similar kinds of apparatus are that they can be placed outside of the room to be disinfected so as to be under the continual observation of the attendant.

It has been found, however, that Trillat's method is more complicated and the apparatus more costly than is required.

1. Deutsche Med. Woch., XXII., 626. 1896.
2. This Report, p. 156.

The addition of calcic chlorid or other salts which necessitates a subsequent troublesome cleaning out, and the system of valves and the subjection of the vapor to a pressure are all unnecessary.[1] Under a sufficiently high degree of heat, the polymerized product is revaporized in the evaporation of the simple aqueous solution of formaldehyde. Though not uniformily successful in their workings, the results obtained with the various generators of this type have been remarkably favorable in the hands of many investigators. (See Formaldehyde, *Disinfection of Rooms.*)

In his experiments for the State Board of Health of Michigan, Dr. Novy[2] found that the polymerization of formalin while undergoing distillation is largely a myth. If rapidly distilled, polymerization rarely occurs. The apparatus which he used was of a very simple kind, consisting of a copper tank shaped like an ordinary tin can. From this neck a small tube in two sections, connected by a short piece of rubber tubing, passes through a keyhole into the room to be disinfected. A funnel topped supply-tube at one side extends to near the bottom of the container. It may be heated with a Bunsen-burner, a gas or gasoline stove, or a kerosene burner. The doctor tells us that the formalin should be boiled as rapidly as possible. A good Bunsen-burner will distil five ounces of formalin, the amount necessary for 1,000 cubic feet of space, within ten or fifteen minutes. Should there be a tendency of the formalin to polymerize, it can be prevented by the addition of five or ten grams of borax. The results obtained in using this apparatus were very favorable; decidedly more so than those which were had with sulphur fumigation, with the same organisms, under the same conditions, and in the same room.

An apparatus devised by Dr. Kinyoun[3] and used in the Marine Hospital Service consists of a metallic disinfecting chamber to which is attached a vacuum apparatus, a small boiler in which formaldehyde is generated by volatilization from a mixture of formalin and calcium chlorid, and a second small boiler from which ammonia is turned into the disinfecting chamber by the evaporation of ammonia water. The ammonia

1. This Report, p. 156.
2. Med. News, LXXII., 641. 1898.
3. Pub. Health Reports, M. H. S., XII., 100. 1897.

is used for the purpose of neutralizing the formaldehyde in the goods after the prescribed period of exposure.

Among the lamps that have been devised for the production of formaldehyde by the oxidation of methyl-alcohol, I think it is safe to say that those in which flat platinized asbestos disks of considerable area are used are the only ones that produce large enough quantities of formaldehyde for the disinfection of rooms, and that, at the same time, are sufficiently simple and economical in construction for general use. Professor Robinson's[1] experiments indicate that the double Bowdoin Generator and the better class of generators which produce formaldehyde from its solution are of about equal efficiency. Dr. Doty,[2] Health Officer of the Port of New York, after making comparative tests of various kinds of apparatus for the production of formaldehyde from formalin, from wood alcohol, and from paraform tablets, says that the Robinson lamp is also an effective method, as his experiments will prove. He adds that the lamp can be purchased for a comparatively small sum, is easily manufactured, and is very satisfactory for house disinfection.

The lamps for the revolatilization of paraform, or formaldehyde in its solid form, are convenient for the production of small quantities of formaldehyde, as, for instance, for its continuous antiseptic effect in the sick-room, or for the disinfection of small spaces. The prevailing high price of paraform is prohibitive of its use in general disinfection. The trade circular states that each one gram tablet of paraform contains one gram of formaldehyde gas. The experiments of Aronson[3] indicate that it is practicable to disinfect rooms with paraform. He claims that one tablet suffices for the disinfection of each cubic metre of room space. He cites the fact that, in this method, the danger of explosion which accompanies the use of Trillat's autoclave is not present.

Rosenberg[4] claims that hoizin, a solution of formaldehyde in methyl-alcohol, is more efficient than formalin. For the vaporization of holzin a small apparatus is used which is not described.

1. This Report, p. 153.
2. New York Med. Jr. LXVI., 517. 1897.
3. Zeit. für Hygiene, XXV., 168. 1897.
4. Deutsche Med. Woch., XXII., 626. 1896.

Temperature.—The higher the temperature in rooms subjected to formaldehyde disinfection, say Abba and Rondelli,[1] the greater the disinfecting power of the formaldehyde. In the summer months, when the rooms are warm and dry, disinfection with formaldehyde is more rapid and certain. The experiments of Dr. Wilson[2] prove to him that temperature exercises a marked effect on disinfection with formaldehyde. In one experiment in which the temperature of the disinfecting chamber was low, sterilization failed to occur, although a large percentage of gas was used. The same fact was also observed by Trillat,[3] and he lays down the rule that disinfection is more efficient if the rooms are previously warmed. Ivanoff[4] found that elevation of temperature increases the bactericidal activity of formalin. Van Ermengem and Sugg also state that formaldehyde is more efficient at higher temperatures. For instance, anthrax spores which were not killed in from three to four hours at 15° C. were destroyed in fifteen minutes when the temperature was 37°.[5] The experience of Professor Robinson[6] indicates that the range of temperature between 50° and 80° F. makes but little difference in the action of the gas.

In a paper read at the meeting of the Massachusetts Medical Society, Dr. David D. Brough[7] gave the results of his investigations for the Municipal Board of Health of Boston, in the use of formaldehyde in the disinfection of rooms. Referring to the question of the influence of temperature, he says: "Within the range of temperature, such as occurs in ordinary disinfection, the gas seems to act perfectly well. With a low temperature, below 35° F., my results were not so satisfactory, even using large amounts, as with a higher temperature. It would seem that very low temperatures interfere with the action of the gas."

Dampness or Dryness.—Abba and Rondelli think that dryness of the atmosphere, in rooms subjected to formaldehyde disinfection, is conducive to efficiency in the disinfecting process. Trillat teaches also that disinfection is not so certain in the

1. Zeit. für Hygiene, XXVII., 49. 1898.
2. Brooklyn Med. Jr., XI., 741. 1897.
3. La Formaldehyde, p. 88. 1896.
4. Centr. für Bak., XXII., 50. 1897.
5. Quoted from Dieudonne, Arbeiten a. d. Kais. Ges., XI., 534. 1895.
6. This Report, p. 168.
7. Formaldehyde Gas as a Disinfectant, p. 14. 1896.

presence of moisture. The experiments of Strehl[1] lead him to conclude that formaldehyde acts more efficiently upon moist matter than upon dry. In the disinfection of rooms, Professor Robinson[2] says that dampness is a disadvantage as it absorbs more or less of the gas and holds the odor in the rooms. Damp test-objects were, however, as easily sterilized as dried ones, but germs in liquids were not killed at any great depth. Novy found that infectious material is much more readily disinfected when it is moist. Even wet spore material is thoroughly disinfected with formaldehyde, whereas such material is not affected by sulphur. He found that the walls and floor of the room to be disinfected, and whatever articles are present (previously spread out as much as possible) should be sprayed with water before exposure to formaldehyde vapor. Owing to the great solubility of formaldehyde, large vessels of water should not be kept in the room to be disinfected. When water is thus kept in the room, scarcely any odor of formalin will remain at the end of twenty hours, whereas, in the absence of such water, the odor at the end of the time mentioned will be intolerable.

Dr. Brough finds that "the gas acts equally well on both wet and dry cultures. This was my experience with silk threads and squares of gauze. Organisms growing in bouillon exposed in Petri dishes could not be killed."

Action on Colors, Fabrics, Metals, Etc.—Experiments were made by Dr. Kinyoun[3] by subjecting samples of wool, cotton, fur, and leather goods of every description to crucial tests, using solutions of various strengths and a saturated atmosphere of the gas. The results obtained were in every way satisfactory. Of over 225 different samples of wool, silk, cotton, linen, leather, and hair subjected, there was no change observed in textile character, even when they were soaked in a strong solution of the gas. Little, if any change occurred in the colors of the fabrics; only three of the number showed any change. These were two shades of violet and one of light red. These were coal-tar colors, and were also quickly bleached by the sun. Iron and steel are attacked by the gas, and more so by its solutions. Copper, brass, nickel, zinc, and gilt work are not acted upon.

1. Centr. für Bak., XIX., 785. 1896.
2. Ninth Report State Board of Health of Maine, p. 180. 1896.
3. Pub. Health Reports, M. H. S., XII., 93. 1897.

The experiments of Professor Robinson indicate that dry formaldehyde gas does not affect polished steel. Dr. Reik,[1] referring to the question whether or not the cutting edge of instruments is dulled when they are subjected to formaldehyde disinfection, says that Drs. Schweinitz and Burnett, of Washington, state that, from the use both of the gas and of the liquid formalin, there has been no influence whatever upon the sharpness of the instruments. In a subsequent paper by Dr. Reik, detailing the experiments performed by himself and Dr. Watson for the purpose of determining the action of formaldehyde gas upon the cutting edge of instruments, he says:

"As to the question regarding the edges of the knives, I tested very carefully their sharpness by means of the kid drum, both before and after sterilization, and I am not able to discover that the gas affects this in any way.. To see whether or not the gas would affect instruments made of other material than steel, I repeatedly exposed the following instruments to the action of the gas; knives with aluminum handles, knives with ivory handles, a hard rubber syringe, soft rubber catheters, a Politzer air bag, and a nickel-plated syringe. None of these objects were in any way affected by the gas."

Formaldehyde gas, say Abba and Rondelli, is injurious to neither clothing, furs, paper, photographs, leather, india-rubber, woodwork, nor metals. It affects colors in nowise, with the exception of a few anilin colors which suffer a uniform change of color. The same is true of the colors of fresh flowers.

It would appear from the testimony of recent experimenters in the disinfection of instruments with formaldehyde that this gas in its dry form, as it may be obtained from paraform, has but little, if any action upon steel instruments, and it is likely that the action of formaldehyde upon steel and iron, observed by Dr. Kinyoun, is due to the simultaneous presence of watery vapor which comes over with formaldehyde gas in the ordinary methods of its production.

Fixation of Stains.—The observations of Rondelli[2] show that formaldehyde gas fixes blood and pus stains so that they are not removable when subsequently washed. Fecal stains are also fixed, but in a slighter degree. This fact should be borne in mind in practical disinfecting work.

1. Bul. Johns Hopkins Hospital, VIII., 261. 1897.
2. Giornale della Reale Soc. It. d'Ig., XIX., 510. 18.7.

Toxicity.—Formaldehyde, when compared with sulphur dioxid, chlorin, and the other gaseous disinfectants, is very free from poisonous qualities. This idea is supported by a consensus of opinion among those who have sought to determine this point experimentally. Aronson[1] found that the inhalation of formaldehyde vapor is borne very well by animals. Guinea-pigs and rabbits left in rooms overnight during disinfection were found well and lively in the morning. After killing the animals, section showed in no case, as might be expected, evidences of serious irritation of the bronchial mucosa. Trillat[2] states that formaldehyde is toxic only after inhalation many hours. Fairbanks,[3] of Boston, while carrying on his experiments in Charlottenberg, shut mice and rabbits in the experimental room where they were left overnight exposed to formaldehyde vapor. There were no injurious effects and, particularly, no conjunctivitis.

Referring to the question of toxicity, Dr. Charles Harrington[4] says that the results produced by the gas on the two rabbits used in his experiments were sufficiently certain to demonstrate the falsity of the theory that formaldehyde exerts no deleterious action on higher organisms and to render further experiments on his part in this direction unnecessary. "The experience of several others who are daily engaged in the work of house disinfection, has shown that animals, such as cats and dogs, which have accidentally been confined in rooms undergoing formaldehyde disinfection, rarely survive the operation when the latter is properly carried out."

As to the influence of formaldehyde on animal life, Dr. Brough[5] says: "Our opportunities for observation in this line have been limited. Dogs and cats which have been left in rooms were found killed. Flies were invaribly found dead. Bed bugs, which were exposed to the direct action of the gas, were likewise killed."

While formaldehyde gas is irritating to the eyes and nose, the general testimony of those who have worked with it and have

1. Zeit. für Hygiene, XXV., 168. 1897.
2. La Formaldehyde, p. 31. 1896.
3. Centr. für Bak., XXIII., 20. 1898.
4. Amr. Jr. Med. Sciences, CXV., 69. 1898.
5. Op. cit., p. 6.

been much subjected to its influence is that no permanent ill results follow ordinary exposures to it.

Disadvantages after Disinfection.—After the disinfection of rooms with formaldehyde, no poisonous substance remains, the odor is comparatively transient and but slightly disagreeable. A temporary airing renders the rooms habitable again. In a schoolhouse, which was disinfected with formaldehyde gas overnight and in which the fumes were very strong in the morning, the windows were thrown open for a while and the regular sessions of the school were held with but little trouble.

Clothing, however, which has been subjected to disinfection with formaldehyde retains for some time quantities of irritating gas which renders it unfit for wearing until after it has been thoroughly aired for several days. But the vapor of formalin which remains in rooms or in clothing can be neutralized with ammonia.

The Disinfection of Rooms.—Before formaldehyde generators were devised, capable of rapidly producing large quantities of the gas, doubts were expressed as to the practicability of successfully disinfecting spaces of large cubic capacity. The work of Trillat, however, did much to remove these doubts.

Some of his experiments were made with an apparatus for the conversion of wood alcohol into formaldehyde: in others, he used his autoclave for the volatilization of formalin to which calcium chlorid had been added.

In one experiment, the disinfection of several rooms with a capacity of 13,135 cubic feet, five litres of alcohol were burned. The temperature of rooms, 12° C.; time of exposure of bacteria in the rooms, two to seven hours. Six animals inoculated with the test cultures of anthrax, diphtheria, and tuberculosis; none succumbed. The two inoculated with tuberculosis were killed in six weeks and found to be healthy.[1]

Other experiments were made with a series of seven rooms, on two different floors, connected by a stairway. Air space, 11,105 cubic feet; alcohol burned, six litres; time of exposure, nine hours; temperature of rooms, 16° C.; anthrax bacilli used as tests, no growth in twenty days; three animals inoculated, all remained well. The same experiment was repeated with the

1. La Formaldehyde, p. 83, 1896.

same cultures, and with the same results. Of the three animals inoculated, none were affected.[1].

In the experiments of Trillat and Roux for the city of Lyon, two connected halls, a large and a small one, with a combined capacity of 49,700 cubic feet, were disinfected. The temperature of the rooms ranged from 4° to 10° C. Infected objects; paper, linen, wood, etc.; germs; pyocyaneus, pyogenes, anthrax spores, prodigiosus, coli; autoclave placed outside the rooms; in operation five hours; formaldehyde used, nine litres; test-objects were in various parts of both halls and at various heights; duration of exposure, thirty-six hours; growth in no culture in two, nor ten, nor thirty days; sterilization of all these germs was absolute in spite of the dimension of the halls.[2]

In his report to the Hospital Commission of Montpelier, Dr. Bosc stated that, in one of his experiments, Trillat's autoclave was set up outside of a ward in a contagious disease hospital. This ward was more than 50 feet long, and had open doors leading into two adjoining rooms at the end opposite to that at which the autoclave was placed. The combined air space of the three rooms was more than 26,000 cubic feet. Three litres of formalin were used; autoclave in action, two and one half hours; only the larger openings around the doors and windows were closed. The germs used were Staphylococcus aureus, B. coli, diphtheria, glanders, pyocyaneus, anthrax spores, etc., dried on pieces of linen, placed in various parts of the rooms and at various heights in the large and one of the small rooms; some, covered; some, open. At various places, also, dust from the Laboratory of Pathological Anatomy, earth from the courtyard, tuberculous sputum on linen, and mixed with sterilized sand, some dried and some only partially dry, or humid, were placed. Some of the samples were exposed five, others, twenty-four hours.

The results were that all pathogenic germs exposed to the gas on pieces of linen, dried or partially dried, and in all parts of both rooms, large and small, were destroyed; the laboratory dust was sterilized, the earth from the pavilion developed only B. subtilis and B. mesentericus. Staphylococcus in the pocket of a coat was killed, but B. coli in the same pocket presented a

1. Op. cit., p. 85.
2. Op. cit., p. 98.

scanty growth on the fifth day. Staphylococcus under a pile of clothing, not destroyed; and B. anthrax in the centre of a mattress was not destroyed; Staphylococcus between the layers of a folded mattress, sterile; B. tuberculosis, dried on linen, in sterilized sand, and in fresh sputum on clothing, was killed. The cultures were observed nearly two months; precautions were taken to neutralize the trace of formaldehyde gas.[1]

In his experiments in the disinfection of rooms, Strüver[2] used various kinds of apparatus for producing formaldehyde. In the disinfection of a room containing 1,252 cubic feet, he used in Münke's autoclave, which is like Trillat's, 800 cc. of formochloral. This contained 200 grams of formaldehyde; 160 grams of which were liberated. The room remained closed twelve hours. The results were: anthrax spores and typhoid bacilli in a tight closet, not destroyed; anthrax spores between the seat and the back of an upholstered chair, not destroyed though their vitality was diminished; typhoid bacilli in the same place, and all of the other samples in the room, as well as the dust of the room, were sterilized; a guinea-pig inoculated with tubercle bacilli, remained well.

In other experiments, rooms were disinfected by the evaporation of holzin. In a room containing 1,959 cubic feet of space, 250 cc. of the solution were used. Typhoid bacilli on linen and anthrax spores on threads were exposed, for twenty-four hours, in all parts of the room; rinsed in weak ammonia solution; anthrax spores all grew, typhoid bacilli killed except where covered with several thicknesses of cotton flannel. In another experiment in the same room with fifty cc. of holzin, anthrax spores alone on threads were used. All were sterilized save those which were covered with three or four layers of cotton flannel.

For the disinfection of the floors of sick-rooms and of schoolhouses by washing them in it, Rosenberg[3] recommends a solution consisting of two tablespoonfuls of holzin to ten litres of water.

In another paper, Rosenberg[4] gives the results of his experiments in the disinfection of rooms with holzin. In a small room

1. La Formaldehyde, p. 113. 1896.
2. Zeit. für Hygiene, XXV., 357. 1897.
3. Deutsche Med. Woch., XXII., 626. 1896.
4. Zeit. für Hygiene, XXIV., 488. 1897.

containing 468.7 cubic feet of air space, typhoid, cholera, diphtheria, and anthrax without and with spores, and streptococci were the test-bacteria. These germs were on silken threads, wrapped in blotting paper, and put in pockets of a vest and coat hung over the back of a chair, under coat collar, and in the coat sleeve. One hundred and ten cc. of holzin used; exposure, one, two, and three hours; all were sterile. Repeated experiments gave the same results. Controls were used.

In practical work, Rosenberg has the floors thoroughly washed with a solution consisting of 100 cc. of holzin to ten litres of water before he sets the apparatus in operation. His object is to soften any germs that may be there, for instance, those in tuberculous sputum.

In the experiments of Aronson,[1] 200 one-gram tablets of paraform were volatilized in a room of 3,550 cubic feet capacity. The bacteria used were staphylococci, streptococci, B. pyocyaneus, typhoid bacilli, diphtheria bacilli, anthrax spores, and B. tuberculosis on gauze, threads, etc. The room remained closed twenty-four hours; most of the samples washed in weak solution of ammonia before transference to culture media or animals; controls the same; all test-objects were completely sterilized, as well as the dust from the floor. In another experiment in the same room only 100 tablets were used; everything sterilized with the exception that anthrax spores were not with certainty.

In the experiments of Gehrke,[2] a room containing fifty-three cubic metres of air space was used. Two grams of paraform per cubic metre were used. They were volatilized in about four hours, and the room remained closed twenty-four hours. The test-organisms used were typhoid, diphtheria, anthrax, cholera, staphylococci, and bacillus pyocyaneus on pieces of linen and cotton cloth, and woolen, linen, and silk threads saturated with bouillon cultures of suspensions of agar cultures, some dry and others damp. In the experiments, all of the test-objects were completely sterilized when they were uncovered, with the exception of anthrax spores which were known to have a high power of resistance. A slight covering, however, sufficed to prevent sterilization of these objects.

The results obtained by Fairbanks,[3] however, in the disinfection of rooms with polymerized formaldehyde vaporized by

1. Zeit. für Hygiene, XXV., 168. 1897.
2. Deutsche Med. Woch., XXIV., 242. 1898.
3. Centr. für Bak., XXIII., 20, 1898.

the action of the hot gases of combustion from a spirit lamp, did not constitute so unqualified a success though they may be termed fairly good. The room was rendered as tight as possible by chinking the windows and then pasting them. The test-organisms were diphtheria, typhoid fever, pyocyaneus, staphylococcus, and anthrax. The most of the samples infected with these germs were sterilized when freely exposed, but a slight protection sufficed to make their disinfection uncertain. The quantity of polymerized formaldehyde used by Fairbanks was much greater than that which is recommended by the manufacturers of the tablets and the apparatus for volatilizing them.

In some of the series of experiments made for the State Board of Health of Maine, the rooms were such as are found in ordinary dwelling-houses, and no precautions, such as pasting and sealing, were taken. Test-objects were placed at different distances from the floor where infection would be more likely to occur. But little difference in results was noted whether the objects were on the floor or several feet above it. In a room containing about 3,000 cubic feet of air space and with the period of exposure eleven or twelve hours, disinfection was done with generators using wood alcohol and with others vaporizing formalin with calcium chlorid. The test-organisms, anthrax spores and diphtheria bacilli, were sterilized when upon cloth or soaked into bits of blanket, but when upon aluminum slips they were not sterilized with certainty.

In the disinfection of a schoolhouse, one litre of formalin for each 3,000 cubic feet of air space was used. The test-objects used were bits of blanket saturated with the water from serum cultures of diphtheria, part of them wrapped in packets with two layers of cloth, and others free in Petri dishes and placed about the room. All the free bits of blanket were sterile; of the packets, one was sterile and five not sterile. For the detailed results of other experiments in the disinfection of rooms, see the Ninth Report, and this report, pages 136-160.

The experience of Professor Robinson has shown him that, in large rooms, it is impracticable to kill virulent germs when covered with one or two layers of cloth, but that the organisms freely exposed or soaked into the meshes of thick blankets are readily destroyed. In windy weather it was also shown that

disinfection is very difficult on the windward side of the house, unless precautions are taken to seal the doors and windows.

Formaldehyde, as a gas for disinfecting purposes, may be obtained from formaldehyde solution by exposing it in open vessels. This method Dr. Doty,[1] the Health Officer of the Port of New York, justly characterizes as extravagant for general disinfection. In the experiments of Professor Robinson,[2] 100 cubic centimetres of formaldehyde solution were poured upon a large pieces of cotton cloth and spread upon the floor. Less than half of the cultures of diphtheria bacilli and staphylococci in different parts of the room were destroyed after nine hours' exposure. The room was of 3,900 cubic feet capacity.

As an alternative to spraying, Nils England[3] recommends, for the disinfection of rooms, the hanging up of sheets wet in one half litre of formalin in which 200 grams of calcium chlorid have been dissolved.

The Department of Health of the City of Chicago reports that fully as good, if not better results have been obtained in a number of disinfections made personally by Dr. C. W. Behm, Medical Officer in charge of the Disinfecting Corps. "In these disinfections formalin was also used, but without the use of any apparatus. Ordinary bed sheets were employed to secure an adequate evaporating surface, and these, suspended in the room, were simply sprayed with a 40 per cent. solution through a common watering-pot rose-head. A sheet of the usual size and quality will carry from 150 to 180 cc. of the solution without dripping, and this quantity has been found sufficient for the efficient disinfection of 1,000 cubic feet of space. Of course, the sheets may be multiplied to any necessary number.

"Cultures, both moist and dry, were exposed for five hours in these experiments—some in sealed envelopes, and others wrapped in three thicknesses of sheets, or folded inside of woolen blankets. Of the former, none showed growth after seventy-two hours' incubation, while the growth was but slight in those wrapped in the blankets. Surface disinfection was thorough, while a much greater degree of penetration was shown in these experiments than that secured by any other method.

1. New York Med. Jr., LXVI., 517. 1897.
2. Ninth Report of the State Board of Health of Maine, p. 176. 1896.
3. La Salute Pubblica, IX., 251. 1896.

"The evolution of the gas from the sprinkled sheets is exceedingly rapid—so much so that it behooves the operator to vacate the room within a very few seconds; while, after starting the ordinary apparatus, he may remain ten minutes or more without serious inconvenience. When the room is opened after five hours, the density of the gas is still so great as to preclude respiration until after doors and windows have been opened some little time.[1]"

Formalin has also been applied to the disinfection of rooms and their contents by spraying. (See Formaldehyhe, *As a Spray.*)

Percentage, or Amount for Room Disinfection.—At the end of the first year's experiments, Professor Robinson[2] stated that at least one litre of alcohol should be used for every 2,000 cubic feet of space to be disinfected, which would be about a quart for a room 15'x13'x10'. At the end of the experimental work of the second year, he states that, for surface disinfection with the lamps using wood alcohol, at least two litres for 3,000 cubic feet should be used, and the room should be kept closed for ten or twelve hours. In the forms of apparatus which volatilize the 40 per cent. formaldehyde solution, at least 250 cubic centimetres for every 1,000 cubic feet should be used, and the room should be kept closed for the same length of time.

In the work of Dr. Brough,[3] using an apparatus for the volatilization of formalin, he found that the results were not trustworthy with the smaller quantities recommended by some experimenters. He says that, "to get satisfactory results in house disinfection, I agree with Dr. Wyatt Johnston of Montreal, that at the very least one pound of formalin to 1,000 cubic feet should be used, and it would be better to use even considerably more. In this city it is the custom to use nearly a quart to the 1,000 cubic feet, and the varying and inconstant results with small amounts have not been repeated."

As to the time of exposure, Dr. Brough says: "In my own tests I have found no difference in results from exposures of 5, 6, 7 hours and upwards. As good results were obtained in the shorter period of time as in the longer. If the results with a

1. Bureau and Division Reports, March, 1898.
2. Ninth Report, State Board of Health of Maine, p. 180. 1896.
3. Formaldehyde Gas as a Disinfectant, p. 15. 1898.

certain amount of gas were not satisfactory with a short exposure they never were with a longer. It would seem that the work of the gas was accomplished quickly."

Dr. Kinyoun's[1] opinion is that not less than 500 cubic centimetres should be used for each 1,000 cubic feet of space. These two investigators concur in the statement that the length of exposure is secondary to the amount of the gas used. A large per volume strength will accomplish the object better and in a shorter time than by using a smaller amount and prolonging the exposure. For room disinfection, under favorable conditions, fully twelve hours' exposure should be given.

As the result of his experiments with various forms of apparatus Strüver[2] came to the conclusion that for sporeless bacteria 1.6 grams of formaldehyde for each cubic metre of space suffices.

In the vaporization of paraform, or polymerized formaldehyde, Aronson[3] states that each one-gram tablet suffices for the sterilization of one cubic metre of room space.

In the experiments of Dr. Novy,[4] he found that two grams of paraform to each cubic metre (60 grams to 1,000 cubic feet) are sufficient to destroy, within twenty hours, all organisms regardless as to whether they are spores or vegetating forms, provided they are wet. For disinfection by the evaporation of formalin, he advises 150 cc. (5 ounces) of the 40 per cent. commercial solution for each 1,000 cubic feet of space, distilling it as rapidly as possible.

In the use of holzin, Rosenberg[5] recommends five cubic centimetres to each cubic metre of space. This quantity usually suffices, but for the sterilization of anthrax spores he would increase the dose.

The results of Rideal's[6] experiments made for the purpose of determining the efficiency of paraform lamps, lead him to the conclusion that ten grams per 1,000 cubic feet suffice in all ordinary cases of disinfection, and if, in special cases, the walls and floors are in addition sprayed with a 0.5 per cent. formalin

1. Pub. Health Reports, M. H. S., XII., 103. 1898.
2. Zeit. für Hygiene, XXV., 357. 1897.
3. Zeit. für Hygiene, XXV., 168. 1897.
4. Med. News., LXXII., 641. 1898.
5. Zeit. für Hygiene, XXIV., 488. 1897.
6. Public Health, X., 60. 1897. London.

solution (2 ounces of formalin per gallon of water) before using the lamp, he believes that this would be the best practical means of disinfection.

Power of Penetration.—In his report of the results of his second year's experiments, Professor Robinson states that formaldehyde has some power of penetration. "Two layers of cotton cloth offer little resistance when the room is saturated with the vapors of the aldehyde, and even four or five layers of cotton can be penetrated with a fair degree of certainty. As regards woolens, test-objects have been frequently killed through one or two thicknesses of blanket in the ordinary time of exposure. But you cannot depend upon the certainty of the action of the gas through more than one thickness of cotton cloth."[1] Again, he says that, in small rooms, when wood alcohol at the rate of two litres to 3,000 cubic feet of air space are used, or 250 cc. of formalin to 1,000 cubic feet are evaporated, "these amounts will penetrate one or two layers of cloth and sometimes several. But, in large spaces, no penetration can be depended upon with that proportion. This can be obtained by increasing the amount used. In small enclosed spaces of a few feet in capacity, with large amounts of the aldehyde, a marked degree of penetration can be obtained. Surfaces are rendered sterile in very short periods, ten or fifteen minutes, by concentrated amounts in limited spaces."[2]

In a bell jar of 580 cubic inches capacity the formaldehyde derived from the volatilization of one tablet of paraform, or even one fourth of a tablet sufficed to sterilize all test-objects in twenty minutes. "Fifteen minutes were found to be ample time for the sterilization of diphtheria in thick woolen blanket."[3] In this bell jar formaldehyde readily passed through a diaphragm consisting of sixteen layers of heavy cloth held in place by a wire hoop. The possible spaces between the hoop and the glass were made tight with melted paraffin. The bacteria above the diaphragm were killed nearly as readily as those below, where the gas was admitted.

In his experiments with formaldehyde in a gas-tight bag, diphtheria cultures and anthrax were almost invariably sterilized, the time of exposure being nine or ten hours.

1. This Report, p. 135.
2. This Report, p. 168.
3. This Report, p. 162.

These results, in their rapidity and certainty, are comparable with those obtained in the metallic disinfecting chamber with the aid of the vacuum system. Dr. Sprague's experiments were made with the Kinyoun-Francis disinfecting chamber, to which is attached a formaldehyde generator, an ammonia generator and a vacuum apparatus. The test-organisms were anthrax, diphtheria, and typhoid bacilli. A smaller percentage of formaldehyde than 20 was found untrustworthy when used for short periods of time. Of twenty-one cultures exposed to 20 per cent. of formaldehyde for sixty minutes, seven gave growths and fourteen were sterile. The author says that "while surface disinfection was accomplished with 20 per cent. of gas after thirty minutes' exposure, as well as after one hour, the results in the interior of the mattress were not entirely satisfactory."[1]

In the experiments of Dr. Wilson,[2] he found that 2 per cent. of formaldehyde gas with the vacuum process sufficed to disinfect anthrax spores in the centre of a mattress in one hour and a half. The temperature of the disinfecting chamber was raised to 65°C.

The conclusion of Dr. Doty[3] is that we cannot depend upon formaldehyde for deep penetration in ordinary disinfection. It can, however, be relied upon to penetrate letters and other thin packages by placing them in an air-tight chamber. Abba and Rondelli[4] say that formaldehyde in the gaseous condition, possesses, of itself, almost no power of penetration. Bedding, linen, clothing, etc., even when they lie lightly upon each other, cannot be efficiently disinfected, no matter how small the room is. The interior of the pile and the covered parts are not sterilized. Gehrke[5] says that formaldehyde is a very efficient agent for surface disinfection, but that it lacks power of penetration. Aronson also coincides with the opinion of the majority of experimenters that, in ordinary disinfection, the power of penetration of the gas is not great. Clothing must be hung up so that all surfaces are exposed.

Though formaldehyde has some power of penetration, the safest assumption in the present state of our knowledge of the

1. Med. News, LXXI., 763. 1897.
2. Brooklyn Med. Jr., XI., 741. 1897.
3. New York Med. Jr.,LXVI., 517. 1897.
4. Zeit. für Hygiene, XXVII., 49. 1898.
. Deutsche Med. Woch., XXIV., 242. 1898.

subject is that, in ordinary room disinfection, we cannot trust this gas to effect much more than a superficial disinfection.

Clothing.—The evidence presented in the foregoing subtopic has an important bearing upon the applicability of formaldehyde to the disinfection of the articles which go under this subheading. As to the disinfection of clothing, Doty says that, "for superficial disinfection—i. e., of hangings, furniture, clothing, furs, silks, and other articles which can be spread out and the surfaces exposed—formaldehyde is an agent of undoubted value."[1]

Abba and Rondelli[2] found that clothing made from light stuffs, suspended freely, may be sterilized.

Lehmann[3] says that when clothes were laid loosely in a trunk and cloths moistened with formalin were placed between them, it resulted that thirty grams of formalin disinfected a suit with certainty.

According to Walter,[4] clothing upon which pus cocci had been dried was sterilized in six hours by spraying it with a 3 per cent. solution of formalin and wrapping it in oilcloth. Anthrax spores were destroyed in forty-eight hours by the same treatment; the clothing remained entirely uninjured.

In his very positive claims for holzin, Rosenberg[5] holds that it is suitable, not only for the disinfection of surfaces, but that, through its power of penetration, it is well adapted to the disinfection of clothing, etc.

Kinyoun[6] reports: "I have not been able at all times to disinfect the interior of pillows and mattresses with certainty, even when a very small room was used for this purpose and a large amount of methyl-alcohol consumed. The surfaces, dust, etc., were every time rendered sterile."

The opinion of Pfuhl[7] is that for the disinfection of clothing, bedding, mattresses, and similar articles, formaldehyde is unsuitable, and that they should be subjected to steam disinfection.

In a paper read before the Montreal meeting of the British Medical Association, Dr. Wyatt Johnston,[8] Bacteriologist to the

1. N.Y. Med. Jr.,LXVI., 526. 1897.
2. Zeit. für Hygiene, XXVII., 49. 1898.
3. Münchener Med. Woch,--Centr. für Bak., XIV., 471.
4. Zeit. für Hygiene, XXI., 421. 1896.
5. Zeit. für Hygiene, XXIV., 488. 1897.
6. Pub. Health Reports, M. H. S., XII., 103. 1897.
7. Zeit. für Hygiene, XXIV., 302. 1897.
8. British Medical Jr., Dec. 25, 1897. (Reprint.)

Board of Health of the Province of Quebec, said that he finds that clothing, in small enclosed spaces, may be disinfected with formaldehyde. "Placing the articles in a cupboard or trunk, and blowing in the vapour usually gave fair penetration, if excess of vapour was used. Pasting up minute cracks does not appear to make much difference. Though no large crevices or draughts should be allowed in the room we found it quicker and less troublesome to generate an excess of the vapour than to paste up cracks."

Afterward he used a portable galvanized sheet iron disinfecting chamber, and still later, bags of "enamelled duck," though at the time of the meeting he had not had time to determine whether the best results are got by blowing in the vapor or by placing in articles which have been sprayed with formalin solutions.

Dr. J. Petruschy,[1] of Dantzic, refers to the unfavorable results obtained by the Dantzic Commission for the testing of formaldehyde for the disinfection of clothing or the undisturbed contents of sick-rooms. Later experiments in the disinfection of clothing hung up in ordinary clothes-presses or wardrobes gave more satisfactory results. The test-organisms were anthrax spores on silken threads and diphtheria cultures and pieces of linen cloth infected with the cultures of the bacillus of diphtheria, saturated with blood or blood serum and then dried. For the generation of the formaldehyde gas, Trillat's autoclave was used, the gas being introduced through a gimlet hole bored in the back of the wardrobe. The door of the wardrobe did not close tightly, thus making the conditions of the experiment resemble disinfection with flowing steam, with the exception that a current of formaldehyde gas instead of one of steam was in operation. The test-organisms were wrapped in filter paper and then placed in the pockets of the clothing. Some were placed in the lower corners of the wardrobe and some in the toe of a long-legged leather boot.

All of the packets in the pockets of the clothing and in the lower corners of the wardrobe were disinfected with certainty after the autoclave had been in operation one hour, but not with

1. Deutsche Med. Woch., XXIV., 527. 1898.

certainty after one half hour's use of it. The packets of anthrax spores in the toe of the boot were not destroyed.

What Professor Robinson says about the power of penetration of formaldehyde indicates that, in the disinfection of ordinary rooms, his belief is that it is impracticable to disinfect with certainty their contents of clothing and bedding at the same time.

Furniture.—Formaldehyde is, undoubtedly, a valuable auxiliary in the disinfection of furniture for which there is no other available method. In the disinfection of upholstered furniture and bed-mattresses, the problem is usually that of surface disinfection merely. For the disinfection of mattresses after cases of typhoid fever, the requirements are sometimes much more exacting.

Kinyoun's experiments led him to conclude that it is doubtful whether the interior of articles, such as upholstered furniture, mattresses, and pillows, can always be disinfected unless a much larger percentage of the gas is applied than was used in his experiments. In the experiments of Professor Robinson[1] to determine the penetrating power of formaldehyde with slips of filter paper soaked in typhoid cultures and placed in the interiors of mattresses, pillows, etc., and using from one half to one litre of alcohol to each 2,000 cubic feet of air space the experiments were all favorable. His later experiments, particularly with the gas-tight bag, indicate the possibility of efficient disinfection when large quantities of formaldehyde are used in small, tight, enclosed spaces.

Abba and Rondelli[2] think that the disinfection of the surfaces of furniture and of walls and floors, particularly of the cracks and crevices in them, cannot be done with certainty, even under favorable conditions.

For the disinfection of furniture, as well as for surfaces of rooms and floors, Dr. Rideal[3] advocates the use of the 0.5 per cent. solution of formaldehyde applied with a spray apparatus of proper construction. The apparatus to which he refers throws a profuse spray so that extensive surfaces can be pretty rapidly and thoroughly drenched.

1. Ninth Report, State Board of Health of Maine, p. 176. 1896.
2. Zeit. für Hygiene, XXVII., 49. 1898.
3. Public Health, X., 60. 1897. London.

Books.—At the suggestion of Dr. J. S. Billings, E. G. Horton[1] made an investigation in the Laboratory of Hygiene, University of Pennsylvania, to determine the value of formaldehyde for the disinfection of books. Formaldehyde vapor was obtained by evaporation from formalin. The books were sometimes stood upon end, and sometimes laid down upon their sides, but were always closed. The bacteria used were the bacillus of typhoid fever, of diphtheria, and Staphylococcus pyogenes aureus. The conclusions drawn by him from the experiments are, that:

Books can be disinfected in a closed space, simply by vapor of commercial formalin by using one cubic centimetre of formalin to 300 cubic centimetres, or less, of air.

The vapor of formalin is rapid in its disinfectant action. The effect produced in the first fifteen minutes is practically equivalent to that observed after twenty-four hours.

An increase in the amount of air to each cubic centimetre of formalin is not counterbalanced by an increase in the length of time of exposure.

In case the disinfection has been incomplete, the vitality of the organisms has been so weakened that they survive only if transferred in a few hours to media suitable for their development.

In the experiments for the State Board of Health of Maine, 50 cc. of formalin poured upon a cloth in the lower part of a disinfecting chamber of 1,089 cubic inches capacity, disinfected books that were standing upon end in twenty-four hours and in forty-eight hours, but those lying flatwise were not disinfected.[2]

Surgical Instruments.—At the International Medical Congress in Moscow, Denter[3] stated that a 2 per cent. solution of formalin sterilized instruments without injuring them. In some experiments made by Professor Robinson with paraformaldehyde in a bell jar, the results indicate that surgical instruments may be rapidly sterilized by the evaporation of polymerized formaldehyde, provided the instruments are in a small and perfectly tight enclosed space. In these experiments, bright pieces of steel suspended in the vapor and beyond the moisture from the alcohol were not coated or corroded. The repolymerization

1. Annals of Hygiene, XI., 754. 1896.
2. Ninth Report, State Board of Health of Maine, 177. 1896.
3. Deutsche Med. Woch., XXIII., 188. 1897.

of the paraform was prevented by pouring a small quantity of alcohol into the evaporating dish with the paraform.

In the experiments of Rosenberg[1] in the disinfection of instruments with holzin in a tight casket, he found that he was able to sterilize them in fifteen minutes. The fumes in the casket were still efficient four and one half weeks without renewal of the holzin. Dr. W. W. Alleger[2] states that he has used 10 per cent. solution of formaldehyde in alcohol for the disinfection of instruments, and that this, so far as he can see, had no bad effect upon the metal or the cutting edge.

Dr. H. O. Reik[3] investigated the value of formaldehyde for the disinfection of instruments. With the instruments in a closed chamber of 1 cubic foot capacity, he sought to determine the minimum quantity of paraform and the shortest time required to disinfect instruments. The paraform was volatilized with a Schering lamp. The micro-organisms used in his experiments were Staphylococcus pyogenes aureus and the anthrax bacillus. He concludes that, for practical purposes, ten or fifteen minutes is a short enough time for the sterilization of instruments, and that this can be done within this time with from three to five grains of paraform.

In an interesting paper presented by Dr. Edward Martin,[4] of Philadelphia, he narrates his experiments with different agents and processes for the disinfection of instruments, particularly of urethral instruments. Exposure of the instruments to formaldehyde vapor given off by paraform in a closed box at ordinary room temperatures proved absolutely efficacious. By this means, not only were new catheters, which are always infected, and old catheters, which had been dipped in putrid urine and thoroughly washed, disinfected, but also those which had been dipped in infected material, either urine or pure cultures of Staphylococcus pyogenes, or the colon bacillus, and had not been washed, were rendered absolutely sterile. This was proved by upwards of a hundred experiments.

In the experiments half a dram of paraform was used, and this still preserved its disinfecting properties at the end of two weeks. He found also that all surgical instruments, even those

1. Zeit. für Hygiene, XXIV., 488. 1897.
2. Amer. Monthly Microscopical Jr., XV., 104. 1894.
3. Bul. Johns Hopkins Hospital, VIII., 261. 1897.
4. Phil. Polyclinic, VII., 60. 1898.

of intricate construction, exposed to the vapor for twenty-four hours were rendered thoroughly sterile.

Disinfection of the Mails.—In the study of formaldehyde as a disinfecting agent, made by Dr. Sprague for the Supervising Surgeon-General, M. H. S., in each experiment packages of letters, in the centre of which were placed dried cultures in sealed envelopes, were securely tied and thrown into the rack of the Kinyoun-Francis disinfecting apparatus. Growths occurred in all cases. The opinion is expressed that if the packages had been perforated, they would have been disinfected in some instances, but the trials were made with sealed letters for the express purpose of ascertaining whether or not it was possible to avoid mutilating them with the punch.

In the experiments for the State Board of Health[1] with paraform volatilized in a small enclosed space and with formaldehyde driven from the generator into a gas-tight bag, the results indicate that this gas probably may be trusted to disinfect packages of letters and other mail matter, especially if the precaution is taken to punch the envelopes. Without this precaution, however, the interior of letters was not sterilized with certainty in experiments No. 5 and No. 7, page 166.

Tuberculosis Sputum.—The well known action of formaldehyde in hardening or coagulating albuminous matter is suggestive of doubt as to its suitability as a disinfectant for fresh tuberculous sputum. This, however, is a question which can be decided only by experimental work. Ascoli[2] says that formalin solutions can be used for the sterilization of those albuminous materials for which the bichlorid of mercury cannot be used. For example, the disinfection of the sputum of tuberculous and pneumonic persons. In the disinfection of a room, Strüver[3] subjected tubercle bacilli to the action of formaldehyde and then inoculated them into a guinea-pig. The animal remained well.

Tubercle sputum upon aluminum and tubercle sputum spread in Petri dishes, and swabs of cotton one half inch in diameter which had been rubbed with the false membrane in the throat of a diphtheria patient, were sterilized in the various experiments made for the State Board of Health. From 300 to 500

1. This Report, p. 161.
2. Giornale d. R. S. Ital. D' Ig., XVI.—Centr. für Bak., XVII., 849. 1895.
3. Zeit. für Hygiene, XXV., 357. 1897.

cc. of formalin had been driven into a room of 3,000 cubic feet with a Bowdoin vaporizer. The time of exposure was from nine and one half to fourteen hours.

Tubercle sputum which Pfuhl[1] rubbed into cloth, dried twenty-four hours, and then exposed to formaldehyde in the disinfection of rooms was sterilized.

Embalming.—Ivanoff[2] sought to determine what power formaldehyde has for penetrating organic tissues. Rabbits and guinea-pigs were infected with bacteria capable of producing general infections. After death, their livers were subjected to the action of formaldehyde gas. His results show that formaldehyde gas penetrates organic tissues slowly. Its disinfecting influence extended only about five millimetres beneath the surface of the liver.

The object of some experiments made by Burckhard[3] was the solution of the question whether human bodies and the bodies of animals could be penetrated with formaldehyde gas so as to destroy pathogenic germs, and thus remove the danger in pathologic work. His experiments indicated that it is impracticable to do this. Formaldehyde mummifies the tissues so far as it acts, but it does not penetrate far.

Trillat, on the other hand, says that formaldehyde diffuses itself rapidly through animal tissues, thus rendering them imputrescible.

Brushes, Combs, Etc.—Lehmann[4] recommends formalin for the disinfection of brushes and combs. He considers it a valuable agent for household disinfection and, particularly, for diseases of the hair.

Ascoli also recommends the vapor from formalin for the disinfection of brushes, books, and other articles in small enclosed spaces, such as trunks, satchels, etc.

As a Spray.—For the disinfection of small spaces, Strüver[5] thinks that spraying with formalin is best. Nils England[6] recommends, for the disinfection of rooms, spraying with a solu-

1. Zeit. für Hygiene, XXIV., 297. 1897.
2. Centr. für Bak., XXII., 50. 1897.
3. Centr. für Bak., XVIII., 257. 1895.
4. Münchener Med. Woch.—Centr. für Bak., XIV., 471. 1893.
5. Zeit. für Hygiene, XXV., 357. 1897.
6. La Salute Pubblica, IX., 251. 1896.

tion of formalin, or hanging up sheets wet in the solution. The room should be sprayed with a 2 per cent. solution and then closed for twenty-four hours. While at work, he states the workman can protect his eyes with goggles, and his nose and mouth with a mask lined with cotton. The hands may be smeared with vaselin. Strehl[1] found that a 10 per cent. solution of formalin spray upon wall-paper sufficed to sterilize anthrax spores and staphylococcus, but that a 5 per cent. solution did not suffice. Dr. Rideal[2] makes an argument, based upon his experiments, that a 0.5 per cent. solution of formaldehyde is strong enough to use as a spray when properly applied, but says, however, that the spraying with this solution should in all cases be followed by the use of a paraform lamp so as to insure the disinfection by vapor of crevices and parts of the room and furniture missed by the spray. The use, however, of so weak a solution as that recommended by Rideal can hardly be considered trustworthy until further work in this direction has been done.

Local Antiseptic and Therapeutic Action.—As a local antiseptic, Schleich[3] has found that formalin-gelatin has very distinct and valuable antiseptic qualities. It is prepared by the addition to 500 grams of purified gelatin in solution of twenty-five drops of pure formalin solution and evaporating over formalin vapor. The resulting solid body is reduced to powder and preserved in the presence of a drop of formalin solution.

Various authors have recommended formaldehyde as an agent for the local treatment of diphtheria, whooping cough, influenza, tuberculosis, and other diseases by inhalation, or otherwise. Aronson[4] recommends for this purpose and for the deodorizing of sick-rooms small lamps acting continuously.

Wood[5] uses the Schering and Glatz lamp for this purpose. By keeping only one or two of the tablets in it, a gentle and constant antiseptic vapor may be diffused throughout the sick-room. In an emergency, and in the absence of this lamp, he has placed the tablets on a narrow, bent piece of tin laid across

1. Centr. für Bak., XIX., 785. 1896.
2. Pub. Health, X., 60. 1897. London.
3. Therap. Monatshefte—Med. News, LXVIII., 381. 1896.
4. Zeit. für Hygiene, XXV., 168. 1897.
5. Medical Times, XXV., 264. 1897.

the top of the common lamp-chimney in the treatment of influenza, diphtheria, etc.

Solis-Cohen has seen such good results in the treatment of tuberculosis of the larynx by means of formic aldehyde solutions that he is tempted to believe that we have in this agent a means of treatment superior to any other that he has ever used. He uses the commercial formalin, ½ to 4 per cent. of formic aldehyde, that is, from 1 to 10 per cent. of formalin. The mucous membrane is cocainized before the application is made.[1]

In a discussion on formaldehyde at the meeting of the Maine Medical Association in 1897, Dr. W. B. Moulton, of Portland, was called upon to give his experience with the use of formaldehyde in connection with an outbreak of diphtheria in his own family. He stated that he had kept formaldehyde vaporizing at a gentle heat in the room where the patient was and also from a lamp on the floor below. It was not uncomfortable to those continually breathing it, but would excite cough in one coming in from the outdoor air.

Dr. C. D. Smith, of the same city, stated that he had made cultures from the throat of Dr. Moulton's boy before and during the use of the formalin vapor, and found that there was a marked inhibition of the power of the Klebs-Loeffler bacillus to grow in cultures. He was satisfied that constant breathing of formaldehyde vapor had been a valuable aid in preventing the extension of membrane in these cases, although antitoxin had been used early and in considerable doses to neutralize the toxin.[2]

Rosenberg[3] praises holzinol very highly in the treatment of whooping-cough and also in pulmonary tuberculosis. For internal use, when the systemic effect of formaldehyde is required, he recommends sterisol, which is a saturated solution of formaldehyde in a solution of sugar of milk. Experiments which he tried upon himself indicate that small doses of sterisol may be taken with impunity for considerable lengths of time, and that the urinary secretion contains formaldehyde for several days and is distinctly antiseptic.

1. The Therapeutic Gazette, XXI., 330. 1897.
2. Tr. Maine Med. Assoc., XII., 604. 1897.
3. Deutsche Med. Woch., XXII., 626. 1896.

Dr. Alexander,[1] of Ohio, reports that he has, for a year, used formaldehyde in its various forms as a medical and surgical antiseptic with excellent results,—as a local application to specific and other ulcers, in diseases of the skin, and in diphtheria, and by inhalation in whooping-cough, hay fever, and other catarrhal troubles.

According to F. J. C. Bird, the strength in which solutions of formaldehyde have been used for certain purposes is as follows:

1:2,500 destroys the most resistant micro-organisms in one hour.

1:500 for the irrigation of catheters, etc., and as a mouth wash.

1:250 to 200 is a general disinfectant solution for washing hands, instruments, etc., in surgery, spraying sick-rooms, and as a deodorant.

1:100 in lupus, psoriasis, and skin diseases.

One part of formaldehyde represents two and one half parts of the full strength, or the 40 per cent. solution of commerce.[2]

When solutions of formaldehyde are used locally, the observations of Gagner and Ascoli should be borne in mind. Gagner[3] found that when the hands were washed with a 2½ per cent. solution of formaldehyde no injury was perceptible, but when a rabbit's ear was touched three times daily with formalin, mummification appeared on the seventh day. As one of the disadvantages of formalin, Ascoli[4] referred to its necrotizing and mummifying action upon the skin. If one applies formalin several times to the ear of a rabbit, or to a mouse's tail, induration follows pretty rapidly and then necrosis of those parts without the existence of suppuration or pain.

As a Food Preservative.—Trillat[5] observed that one kilogram of beef, immersed five minutes in a 1:250 solution of formalin, was preserved twenty days. This is one of the many observations which tend to show very conclusively that formaldehyde is a very efficient preservative. The most important question, however, from the point of view of public health is whether

1. New York Med. Jr., LXV., 53. 1897.
2. Pharmaceutical Jr.—Pittsburg Med. Review, XI., 74. 1897.
3. Centr. für Bak., XIV., 472. 1893.
4. Giornale d. R. S. Ital. D' Ig., XVI.—Centr. für Bak., XVII., 849. 1895.
5. La Formaldehyde, p. 47. 1896.

formalin exerts any harmful action. The experiments of Gottstein[1] tend to show that food products are hardened and spoiled after treatment with formaldehyde as a preservative. The investigations of Lederle[2] teach him that the use of formalin for the preservation of milk should be prohibited.

FREEZING.

Upon most disease germs, the effect of low temperatures is too uncertain to permit their application to be considered as a trustworthy method of disinfection.

In the experiments of Dr. T. M. Prudden,[3] carried out for the purpose of learning the effects of freezing in water, on various species of bacteria, the specimens were kept frozen for extended periods of time at a temperature of from 14° to 30° F. Water which contained Staphylococcus pyogenes aureus in innumerable numbers showed 49,280 to the cc. after sixty-six days, and a sample which contained the bacillus of typhoid fever in innumerable numbers still contained over 7,000 after one hundred and three days' freezing. Successive freezings and thawings, however, were found more destructive of bacteria than the uninterrupted action of cold.

In the paper of Dr. Weiss[4] giving the results of the experiments which he carried out in the Institution for Infectious Diseases in Berlin, he refers to some work which preceded his own. In connection with the winter outbreak of cholera in Nietleben in 1893, Professor Renk experimented for the purpose of determining the capability of the cholera spirillum to withstand low degrees of temperature. He concluded that ice which is eight days old ceases to contain cholera germs capable of development.

About the same time Uffelmann made a similar study of the question, using in some of his experiments sterilized water to which cholera bacilli had been added, and in others bouillon cultures. He found that the cholera spirillum possesses a considerable degree of resistance to cold; it survives a temperature of

1. Deutsche Med. Woch., XXII., 669, 797. 1896.
2. N. Y. Med. Jr., LXVI., 526. 1897.
3. Medical Record, XXXI., 344. 1887.
4. Zeit. für Hygiene, XVIII., 492. 1894.

—24.8° C., but in none of his experiments did spirilla survive the freezing temperature more than five days.

In Abel's experiments cholera spirilla were destroyed with certainty after eight days' exposure to the temperature of —20°.

On the other hand, Dr. Schruff found that cholera bacilli retained their vitality after they had been exposed to the freezing temperature at various times from September to May.

The experiments made by Dr. Weiss indicate that the length of time during which cholera spirilla may survive freezing temperatures depends upon various circumstances. In bouillon, the vitality was retained much longer than in water which contained but a few drops of bouillon. They were rapidly destroyed in cholera stools, even more rapidly than in water. Weiss, therefore, concludes that under ordinary circumstances cholera spirilla in stools are rapidly destroyed during cold weather, and he apprehends no danger of the transmission of cholera through ice.

Professor J. Forster,[1] of Amsterdam, found that a variety of bacteria are capable of growth and multiplication and of discharging their vital functions when kept at the freezing point.

FURNITURE.

Upholstered furniture can be disinfected by thoroughly spraying it with a disinfecting solution, as is the official practice in Paris. The spray apparatus used should be more like the sprayers used by orchardists than those made by the manufacturers of medical and surgical instruments. They should throw a fine, but profuse spray. In the absence of a spray apparatus, the disinfecting solution can be applied with a brush or a sponge, or washed or wiped thoroughly with a cloth squeezed out of the solution. For general use, a 3 or 4 per cent. solution of lysol is suitable. When formaldehyde is used for the disinfection of the rooms, this gas may be trusted to sterilize the furniture of the rooms provided it is freely exposed to it. When there is any doubt as to the efficiency of the disinfection of upholstered furniture it is a good plan to expose it for several days to the action of direct sunshine, when that is practicable. (See Light —*The Real Value of Light as a Disinfectant.*)

1. Centr. für Bak., XII., 431. 1892.

GUAIACOL.

The disinfectant properties of guaiacol were investigated by Kuprianow.[1] His conclusions are, in part, as follows: Guaiacol is not so powerful a disinfectant as carbolic acid and cresol. For this reason it is not suitable for external use as a disinfectant. The addition of 33 per cent. of alcohol increases the disinfecting activity of guaiacol. Guaiacol and creasote have an especially energetic action when applied to the bacillus of tuberculosis, but further experiments are needed to determine its value in this direction. Chemically pure guaiacol is much less irritating than carbolic acid and cresol. The absence of toxic and caustic qualities render guaiacol very suitable for internal use.

HANDS.

Probably no point relating to disinfection has brought out more discussion and has been the motive of more laboratory and clinical investigation than the question of how sterilization of the hands may be accomplished with the greatest certainty and rapidity. The loss of time involved in some of the methods calls for patience on the part of the surgeon, but a little trouble will not deter him who sympathizes with the words of Bergmann, of Berlin, that "the touch of the surgeon's hands plays the chief part in the etiology of the spetic diseases of wounds, and the slightest touch of the skilled hand of the surgeon may bring the greatest harm."

The older method of disinfecting the hands consisted in the preliminary scrubbing in soap and water, followed by soaking them in a carbolic acid, a mercuric chlorid, or other disinfecting solution. The investigations and recommendations of Fürbringer led to quite a wide introduction of his process which consisted, after the preliminary dry cleansing of the finger nails, in washing and brushing with soap and hot water two minutes; the application of 80 per cent. alcohol, two minutes; washing with a disinfecting solution (mercuric chlorid or carbolic acid) before the alcohol is fully evaporated; drying in the air.

1. Centr. für Bak., XV., 933, 981. 1894.

In testing Fürbringer's method Roux, Jules, and Reynes[1] found that the results were not perfect, but that they were better than the old process; they, therefore, recommended it.

The greater part of the discussion which has taken place in regard to the disinfection of the hands has related to the method of action and the efficiency of alcohol as a germicide. The original idea of Fürbringer was that the role of alcohol in the disinfecting process which bears his name is the removal of oil from the skin, thereby permitting the disinfecting solutions to penetrate more easily.

Reinicke[2] went farther and claimed that alcohol has a germicide action of its own. He found that by vigorous brushing of the hands with alcohol five minutes, with or without the preceding use of soap and water, followed only by rinsing in sterilized water, the culture media remain completely sterile. In his experiments with the Fürbringer method, by extending the time, particularly in using the soap and water, colonies were very infrequent even when the sublimate was precipitated with a solution of ammonium sulphid. Similarly good results were obtained when lysol was used instead of sublimate.

Kroenig[3] refers to Fübringer's explanation of the action of alcohol and suggests that a partial or temporary sterilization of the hands may be due to the shrinking or contracting effect of the alcohol upon the epidermis, thereby imprisoning the microorganisms and making their removal more difficult. Some of his experiments give some support to this supposition. Other experiments seem to indicate that the subsequent action of water by softening the epidermis has a tendency to release the bacteria. The disinfecting effects achieved by Fürbringer are, therefore, in the opinion of Kroenig, only apparent. In conclusion, he states that the hands may be considered sufficiently disinfected when the adherence of the bacteria to the skin is not easily loosened and when the inhibitory action of the antiseptic continues after the transplantation of the bacteria. In short, when the hand ceases to be able to infect.

1. Comptes rend. de l'Acad. etc.—Centr. für Bak., V., 264. 1889.
2. Centr. für Gynakol.—Centr. für Bak., XVII., 916. 1895.
3. Centr. für Gynakol.—Centr. für Bak., XVII., 915. 1895.

Ahlfeld,[1] who is the director of a large institution for the instruction of midwives, was in a position to test Reinicke's methods very thoroughly. The number of his experiments was far more than a thousand upon the hands of 215 different persons. In applying the alcohol he preferred, in his later work, pieces of flannel to the brush. The use of sublimate without alcohol gave disappointing results.

Series A. The hands were scrubbed and cleansed five minutes in very warm water and common toilet soap, cleansing and trimming the nails at the same time; two minutes in alcohol of 96 per cent.; three minutes in 3 per cent. soap-cresol solution (lysol?); five minutes rinsing in hot sterilized water. One hundred and sixty-two experiments; hands not sterile in 70 per cent.

Series B. Five minutes in soap and water; two minutes in alcohol; five minutes rinsing. Fifty experiments on the same number of students; hands sterile in 90 per cent.

Series C. Five minutes in soap and water; three minutes in cresol-soap solution; five minutes rinsing. No alcohol used. Forty-seven experiments: the hands sterile in 66 per cent.

Series D. Five minutes with brush, soap and water. Three hundred and eighty-nine experiments: hands sterile in 14.1 per cent. Upon his own hands, however, Ahlfeld had his fingers sterile in 82 per cent. of twenty-two experiments.

Thus far, the best results were in series B, in which alcohol was used two minutes preceded by soap and water five minutes.

Series E. In this series he sought to determine how far the process might be simplified without impairing its efficiency. The nails were shortened and cleansed without water. Then: one minute, washing in soap and water without brush; two minutes, in warm water; two minutes, in alcohol; five minutes, in sterile water. Fifty-four experiments upon the same number of pupils: all but one succeeded in sterilizing her finger, or 90.7 per cent. From this series he draws the conclusion that the brush is not absolutely necessary, and that the time for the preliminary cleansing can be reduced to three minutes.

Series F. After the preliminary cleansing of the nails without water, three minutes, in hot water without soap; two minutes, in alcohol; five minutes, in sterilized water. Eighteen

1. Deutsche Med. Woch., XXI., 851. 1895.

persons, of whom twelve, or 66.6 per cent., sterilized their finger. The results, therefore, are not so good when soap is omitted.

Series G. After the preliminary dry cleansing of the nails and trimming them; two minutes, in soap and water without brush; one minute, in hot water, rinsing in sterilized water; three minutes, with alcohol; five minutes, in sterilized water. Thirty-six pupils: 91.6 per cent. of successes or sterile fingers.

Series H. In this series, the time for soap and water was lengthened one minute and the alcohol was applied with flannel instead of with gauze as in some of his experiments. After the preliminary dry cleansing of the nails and shortening them: three minutes, with soap and water without brush; three minutes, with alcohol applied with flannel; five minutes, in sterilized water. Fifty-two experiments on forty-seven persons with 98.1 per cent. of them successful.

The only person who failed to sterilize her finger repeated the experiment a few days later and succeeded.

In these experiments, extended through nearly a year, Ahlfeld thinks that he has shown that we may dispense with the brush and such disinfectants as carbolic acid and the cresols, all which tend to roughen the hands.

As to whether his method suffices when it is known that the hands have been infected with pathogenic micro-organisms, he says that, in thirty-eight instances after his hands had been soaked in the petrifying discharges from disintegrating carcinomatous and fibromatous growths, etc., they were rendered sterile thirty-seven times, or in 97.4 per cent. of the experiments. In the one instance in which there was a failure, the first experiment of the series, sublimate was used, but no alcohol.

In most of his experiments Ahlfeld disinfected but one finger. The disinfection of the whole hand would, of course, occupy more time.

In the investigations of Dr. Leedham-Green,[1] of Birmingham, England, he succeeded in only a small percentage of his experiments in completely sterilizing the hands with soap and water, followed with pure or 96 per cent. alcohol. The number of his experiments was only thirty-seven.

With reference to the cause of Leedham-Green's unfavorable results, the details of the experiments are too brief to enable

1. Deutsche Med. Woch., XXII., 360. 1896.

Ahlfeld[1] to give an opinion as to the cause of his failures. In contrast with Green's results, he refers to those obtained with hot water and alcohol disinfection by the female pupils in the first course of that year. Of fifty pupils in their first practice, forty-six achieved a complete sterilization of a finger. Of the other four, three succeeded at the second trial, and the other one at the third.

In eighty bacteriologic tests on the fingers of midwives or nurses, prepared for obstetric investigations, only four gave unsuccessful results, and in three of these they were the fingers of unskilled persons.

Further, even when the hands of Dr. Ahlfeld and his assistant had been soaked in the secretions of a case of septic puerperal metritis, they were fully sterilized with the hot water and alcohol process, even after the septic fluid had been allowed to dry on the hands half an hour.

He again refers to the fact that his experiments numbered far over a thousand before he published his results.

In another series of experiments made by Ahlfeld[2] and his assistant Vahle, their object was to determine *how* alcohol acts. Four explanations have been presented: 1. Fürbringer assumed that it freed the hands from oils and that thereby the action of the disinfecting solutions subsequently used was facilitated. 2. Reinicke also believed that the solvent action of the alcohol on fats accounts largely for its value, but ascribes to it some germicide action. 3. Kroenig thinks that the disinfectant action of alcohol is a deceptive one,—it does not kill the bacteria, but by its absorption of water causes the epidermis to shrink and mechanically imprison them. 4. Alcohol is a true bactericide, but only when the micro-organisms contain water.

In the disinfection of the hands, the importance of the preliminary treatment with soap and hot water is shown in these later experiments of Ahlfeld and Vahle, in which dried threads with staphylococci were not sterilized in alcohol in five minutes, but moistened threads were absolutely sterilized in the same space of time. As to the strength of the alcohol, there were 88.8 per cent. of successes with 96 per cent. alcohol, and only 81.2 per cent. of sterilizations with 48 per cent. alcohol.

1. Deutsche Med. Woch., XXII., 361. 1896.
2. Deutsche Med. Woch., XXII., 81. 1896.

In still another communication, Ahlfeld,[1] referring to the results obtained by Poten, characterizes his methods as faulty and leading to faulty conclusions. In determining the efficiency of a method of hand disinfection, it is very essential that the scrapings from the spaces beneath the nails be tested. He claims that, thus tested, the hot water-alcohol method of disinfection gives very nearly 100 per cent. of successes.

Before making extended experiments with this method of disinfection, he had tested bacteriologically other methods for disinfecting the hands, carbolic acid, 3 per cent.; soap cresol, 3 per cent.; tricresol, 3 per cent.; sublimate 1:1,000; sublimate-alcohol 1:1,000; washing with soap and hot water, etc. He found all these methods give results inferior to those with the method advocated by him.

He states that Poten is in error in assuming that in his experiments Geppert's precautions were not observed. The alcohol disinfection is not only superior to all other methods for those who are experienced in its use, but it is the safest and most efficient to be put into the hands of persons who are inexperienced.

As to the certainty of the method, he says that inexperienced persons in the disinfection of one finger can, in 98 per cent. of the experiments, secure absolute sterilization, and 87 per cent. in disinfecting the whole hand. In disinfecting his own hands, from 99 to 100 per cent. of absolute sterilizations can be attained in the experiments. He refers to a former work in which he states that 48 per cent. alcohol possesses quite a high degree of disinfecting power.

Fürbringer and Freyhan,[2] referring to the experiments of Leedham-Green in which the hands were artificially infected with pure cultures, say: "Such conditions are too widely different from the conditions in practice to serve as data for a conclusion. These authors are convinced that in the inunction of cultures into the hands the bacteria penetrate rapidly into the numberless spaces of cuticular scales and that, furthermore, they enter the orifices of the hair follicles and the spiral sudoriferous glands so that it may be impossible to sterilize the hands.

1. Deutsche Med. Woch., XXIII., 113. 1897.
2. Deutsche Med. Woch., XXIII., 81. 1897.

They give the results of a series of new experiments from which the authors conclude that, after the alcohol treatment, it is desirable to use a disinfecting solution as originally prescribed by Fürbringer. Fürbringer is now convinced that the antiseptic influence of the alcohol is not due principally to its solvent action upon the oily matter of the skin, but that Ahlfeld is right in assuming that alcohol is a strong bactericide for the microorganisms of the hands. Fürbringer and Freyhan think that alcohol acts in three ways: (a) it has a bactericide action of its own; (b) it prepares the way for other disinfectants by removing the oils and otherwise; (c) it removes the superficial epithelial scales and their bacteria and washes them away.

Dr. Goenner,[1] of Basle, repeated the experiments of Ahlfeld and Vahle and of Leedham-Green, supplemented by original experiments. His results are to the effect that alcohol is a disinfectant, but its action is not so great as that of sublimate. The practical lesson is, therefore, that alcohol should be used in a bowl of sufficient size so that the hands may be wholly immersed for a specified time and that the sublimate disinfection should immediately follow.

Epstein's[2] experiments confirmed the conclusions of Reinicke and Ahlfeld that alcohol has a germicide action of its own, but he found that, as the strength of the alcohol is diluted down to 50 per cent., its disinfecting power increases, but that there is a diminution of this power as the dilution is carried below 50 per cent.

In a paper by Dr. Menge,[3] of Leipzig, he states that the opinion of Dr. Fürbringer is more and more approaching the view taken by Reinicke and Ahlfeld and Vahle, although he does not go so far as these investigators have in their opinion as to the efficiency of mechanical disinfection of the hands, and, particularly, of the action of alcohol.

According to Menge, 70 per cent. alcohol possesses advantages in the disinfection of the hands which no other agent has. It has a distinct germicide action against sporeless bacteria. A second advantage is that it saturates all of the superficial layers

1. Centr. für Gyn.—Münchener Med. Woch., XLV., 337. 1898.
2. Zeit. für Hygiene, XXIV., I., 1897.
3. Münchener Med. Woch., XLV., 104. 1898.

of the skin, thus having an advantage over watery solutions of disinfectants. A third advantage is that it does its work without injury to the skin.

By virtue of the hardening influence of alcohol and its power of abstracting water, the more resistant forms beneath the epidermis are retained. If, however, the hands are subsequently soaked in water or the fluids of the body, the epidermic layer again becomes softened and enables these more resistant bacteria to escape. To meet the requirements of surgical gloves, Menge treats cotton or silk tricot, or stockinet gloves by immersing them in a solution of 100 cc. of xylol and 10 grams of a soft paraffin which melts at a temperature of 45° C. The gloves are allowed to remain fifteen minutes in the warm solution. They are then wrung out and dried in an oven. Water and acetic fluids flow from the surface of these gloves as they would from the feathers of aquatic birds. They are not, however, impervious to liquids under pressure. They present a comparatively smooth surface, are comfortable to the hands, and can be cleansed with soap and hot water and sterilized by steam.

Menge has also used the paraffin-xylol solution as an application to the hands, after alcohol has been applied, for the purpose of preventing the subsequent softening of the epidermis and the liberation of bacteria. It also protects the skin from the penetration of infectious material. It can be removed by rubbing the hands with ether and washing with soap and hot water. The method which Menge recommends for the disinfection of the hands is,—mechanical cleansing with hot water and soap applied with a brush, the nails having been carefully cleansed during the process; disinfection of the skin with an aqueous or a weak alcoholic solution of sublimate; soaking the hands with 70 per cent. alcohol and drying with a sterile towel; application of the paraffin-xylol to the hands and again drying with a sterile towel.

In the investigations of Dr. Howard A. Kelley,[1] of Johns Hopkins University, soap and water were found to be utterly inadequate to remove the germs even when the scrubbing is very thorough and extended to from ten to twenty-five minutes.

1. Amer. Jr. of Obstetrics, XXIV., 1414. 1891.

The use of mercuric chlorid solutions up to 1:500, following the use of soap and water, leaves innumerable colonies after the precipitation of the mercuric chlorid with ammonium sulphid solution. A few experiments made with a 4 per cent. solution of lysol and with hydrogen peroxid were all unsuccessful. Some experiments were made with Fürbringer's method (the number not stated). It was shown to be inefficient in almost every instance.

He found the most efficient method of disinfecting the hands to be scrubbing them for ten minutes with soap and water at the temperature of 104° F.; immersion in a saturated solution of permanganate of potash until the skin is stained a deep mahogany red or almost black; immersion in a saturated solution of oxalic acid until they are completely decolorized and of a healthy pink color; rinsing the oxalic acid off in warm sterilized water.

In fifty experiments with disinfection by this method, forty-four remained without growth. The remaining six yielded respectively 80, 20, 10, 9, 5, 4 colonies—enormous quantitative difference in favor of permanganate of potash and oxalic acid as contrasted with soap and water and corrosive sublimate.

Dr. Roswell Park[1] calls attention to the remarkably efficient properties of mustard as a sterilizing agent for the hands. His practice is to scrub his hands thoroughly with a mixture of green or other soap, corn meal, and mustard flour, using this about five minutes. He has no hesitation in going from a necropsy to the operating room, if his hands are thus disinfected. He finds the mustard to be an admirable deodorant.

Dr. L. S. McMurtry also recommends mustard for the disinfection of the hands. The following method he has found to be efficient and simple:

The nails are shortened and the spaces about them cleansed. The hands and arms are scrubbed with a liberal quantity of green soap and hot water with a stiff brush for ten minutes. The hands and arms are dried with a towel, the nails and underlying spaces are again carefully cleansed. Ordinary mustard flour, mixed with warm sterilized water in the hands, is applied with friction for five minutes and then washed with warm sterilized water. The hands are now thoroughly bathed in strong

1. Med. News.—Philad. Polyclinic, V., 126. 1896.

alcohol, 80 per cent. The hands receive a final washing in a stream of warm water running over them, brushing them again well.[1]

It is not known to the writer whether the value of mustard flour for the disinfection of the hands has been determined bacteriologically. Koch,[2] however, found that anthrax spores were not killed in ten days with oil of mustard, but there was only a weak growth. The development of anthrax bacilli, however, was restrained in a marked degree with 1:330,000 of mustard oil, and 1:33,000 arrested their growth completely.

For the disinfection of the hands, Loeffler recommends very highly a 3 per cent. cresol-anytol solution. It is very efficient and it affects the skin but little. (See Anytin and Anytols.)

HEAT.

As a disinfecting agent heat has been applied as dry heat (hot air), and as moist heat (steam and boiling). In their experiments with hot air, Koch and Wolffhügel[3] found that sporeless bacteria are destroyed in an hour and a half by hot air at the temperature of 100° C. (212° F.); that anthrax spores require for their destruction a temperature of 140° C. (284° F.) three hours. The impracticability of hot air disinfection is indicated by their statements that, in using hot air, the heat penetrates so slowly that with a temperature of 140° the interiors of quite small bundles of clothes, or of pillows are not disinfected in three or four hours; and that the action of hot air of 140° injures most objects more or less. The experiments of Klein and Parsons[4] also show very conclusively the inefficiency of the hot air disinfectors which had been largely in use.

These experiments and the practical experience of health officers have gradually taught that, as compared with steam, hot air is much less certain and rapid in its action. It is, therefore, now but little used except in special work, on a small scale.

1. Medical Standard, XX., 53. 1898.
2. Mittheil. aus dem Kais. Ges., I., 234. 1881.
3. Mittheil. aus dem Kais. Ges., I., 301. 1881.
4. Rpt. of the Med. Officer of the Local Govt. Bd. for 1884, p. 218.

HEAT AS AN AUXILIARY.

By heat as an auxiliary in disinfection, reference is made to temperatures below that of the thermal death points of the bacteria in question, and often far below. This increase in the activity of disinfecting solutions as their temperatures are increased is illustrated by Behring's[1] observation that the bacillus of cholera and sporeless anthrax bacilli were destroyed with a 1:100,000 solution of mercuric chlorid at 36° C. (96.8° F.), but at 3° C. (37.4° F.), these bacteria were not destroyed with a lesser strength than 1:25,000. Again with a 1.4 per cent. solution of washing soda, anthrax spores were killed in ten minutes at from 80° to 83°; in fifteen minutes at 77°; in twenty minutes at 75°; and in from 30 to 60 minutes at 70°.

Remouchamps and Sugg[2] found that pieces of linen soiled with cholera and typhoid dejections were completely sterilized with a 1 per cent. solution of carbolic acid, creolin, or lysol in thirty minutes when the solution had a temperature of 122° F., but that the sterilization required two hours when the solution was cold.

In the experiments of Heider,[3] the anthrax spores used by him in his tests resisted the action of a 5 per cent. solution of carbolic acid thirty-six days at the temperature of an ordinary room, but a solution of the same strength disinfected in from one to two hours at the temperature of 55° C. (131° F), or in three minutes when the temperature was 75° C. (167° F.). The same increased efficiency was observed with other solutions as their temperatures were increased.

In his investigations of the value of soap solutions of crude carbolic acid, Nocht[4] learned that the germicidal action varies at different temperatures. Anthrax spores in a cold solution of carbolic acid were not destroyed in six days, but at the temperature of 50° their destruction was complete in six hours. In practice he recommends the use of a 3 per cent. hot solution of soap into which up to 5 per cent. of crude carbolic acid can be poured and a clear solution can thus be obtained. This used at

1. Bekampfung der Infectionskrankheiten, II., 15, 89. 1894.
2. Revue D'Hygiene, XIII., 640. 1891.
3. Centr. für Bak., IX., 221. 1891.
4. Zeit. für Hygiene, VII., 521. 1889.

temperatures from 40° to 50° C., he found to be efficient for the disinfection of clothing, leathern articles, etc.

Experimenting with lutidin, Blyth[1] failed to disinfect threads infected with bacterium termo in twenty-four hours with a 1.15 per cent. solution of this agent. The temperature was 15°, but at the temperature of 35.5° a 0.5 per cent. solution of lutidin disinfected absolutely.

Vrijheid's[2] experiments show very plainly the advantage of using disinfectant solutions at somewhat elevated temperatures. He used anthrax spores in aqueous suspensions in which silken threads were soaked. After they had been dried, these threads were subjected to the action of a 1:1,000 solution of mercuric chlorid at various temperatures for certain lengths of time.

In the experiments with the temperature of the disinfecting solution from 10° to 35° C. (50° to 95° F.) there was no certainty of disinfection, whether the sublimate solution acted one minute or five, but when the temperature of the solution was from 40° to 48° C. (104° to 118.4° F.) sterilization was invariably perfect whether the threads were exposed five minutes or one. The cultures were kept under observation three months.

Pane's[3] experiments with carbolic acid led him to the following conclusions:

A ½ per cent. solution of carbolic acid at a temperature of 37° destroys the Staphylococcus pyogenes aureus four or five times as rapidly as at 15°. A 5 per cent. solution of carbolic acid acts upon anthrax spores about sixty times more rapidly at 37° than at from 16° to 18°.

Experimenting with mercuric chlorid, he found that solutions from 1:20,000 to 1:5,000 act four or five times more powerfully at the temperature of 37° than at 15°.

HYDROGEN PEROXID.

In a paper by Dr. B. W. Richardson,[4] he refers to his study of this substance begun in 1858. He defines it as "an oxygen atmosphere in solution." It is not, however, a mere mixture, but a peculiar chemical compound. The oxygen can be made

1. Manual of Public Health, p. 313. 1890.
2. Nederlandsch Tidsch., v., Geneesk. XXXII., 1074. 1896.
3. An. dell' Ist. D'Ig. Sper. dell' Univ. di Roma, II., 91. 1890.
4. The Lancet, I., 1891, 707.

to accumulate volume by volume, until the volume of water, say as much as would fill a pint measure, can rise to 10, 20, 30, and some say even over 100 volumes of oxygen before complete saturation is reached and a volatile body is formed.

The combination of the added oxygen in hydrogen peroxid is stable in the presence of some substances, unstable and easily evolved in the presence of others.

Dr. C. H. Brown,[1] of New York, makes the following statements relating to ozone and hydrogen peroxid:

"It is considered that oxygen is capable of three allotropic modifications, viz.:

"O_2, ordinary (inactive) oxygen; O_3, ozone; and O_1, active oxygen.

"The latter form of oxygen (O_1), which only exists in *status nascendi,* is the most powerful oxidizing agent known, and is capable of combining with inactive oxygen (O_2), and forming ozone (O_3). Ozone is also a powerful oxidizer, in fact not much less so than O_1, and as it is only formed in the presence of O_1, a distinction is in many cases difficult, and the chemical action is often ascribed to ozone, as for instance, as stated above, in the case of hydrogen peroxid ($H_2 O_2$), the oxidizing agent of which is not ozone (O_3), but nascent or active oxygen (O_1).

"The following distinctions, arranged according to Baumann,[2] still further show the difference between ozone and hydrogen peroxid, and the relation that O_1 bears to each.

"1. Active oxygen combines with inactive oxygen forming ozone, which is easily demonstrated in all cases in which its formation is not inhibited by the presence of easily-oxidizable bodies.

"2. Active oxygen oxidizes water, and forms hydrogen peroxid. This does not take place when ozone acts on pure water.

"3. Active oxygen oxidizes the nitrogen of the atmosphere forming nitrous and nitric acids. Ozone has no effect on nitrogen.

"4. Active oxygen oxidizes carbon monoxid to carbonic acid; this is affected by ozone.

---

1. Medical News, LVIII., 180. 1891.
2. Zeitschsift für Physiol. Chemie, vol. V. (Quoted by Brown).

"Positive (O_1) and negative active oxygen (O_1) act essentially in a similar manner. It is certain, however, that the action of hydrogen peroxid ($H_2 O_2$), whose oxygen according to Schönbein is positive, is much less intense than that of ozone, O_3. Ozone is a gas, hydrogen peroxid a liquid, and this fact alone necessitates a different action of the two toward various bodies. In both (apart from the positive or negative electricity, a difference which may be safely assumed) the oxidizing factor is O_1; in the one compound bound to inactive (latent) water, in the other to inactive oxygen." He further proceeds to give the reactions which distinguish between ozone and hydrogen peroxid.

The hydrogen peroxid tested by the Committee of the American Public Health Association[1] contained 5 per cent. of sulphuric acid, and the results are equivocal.

Von Hettinga Tromp[2] recommends hydrogen peroxid as a convenient, efficient, and harmless agent for the sterilization of drinking water. Ordinarily, it sufficed to add one part of hydrogen peroxid to 10,000 parts of water to insure its sterilization in twenty-four hours, yet the rapidity of the action depended very much upon the number and species of the contained micro-organisms. A water which contained 19,600 germs per cubic centimetre, required 1:50,000, and a water that contained 34,850 germs required 1:10,000 to sterilize it in one day.

Uffelmann[3], repeating these experiments, did not find hydrogen peroxid so efficient when largely diluted as Hettinga Tromp did. Even in the concentration of 1:5,000 or 1:3,000, hydrogen peroxid was not so efficiently germicidal.

At the suggestion of Uffelmann, Altehofer[4] made a careful repetition of the experiments of Hettinga Tromp. He found that neither 1:5,000 nor 1:2,500 of hydrogen peroxid sufficed to sterilize a water which had relatively few germs (560 to 1,800 per cubic centimetre); but the results were better with 1:10,000. A water to which typhoid and cholera germs had been added in considerable quantity required 1:1,000, and twenty-four hours' action of the disinfectant.

1. Tr. Am. Public Health Association, XI., 207. 1885.
2. Quoted from Traugott.
3. Jahresbericht über die Fortschritte u. Leistungen auf dem Gebiete der Hygiene, VI., 48. 1888.
4. Centr. für Bak., VIII., 131. 1890.

In Pane's[1] experiments, a 1 per cent. solution of hydrogen peroxid destroyed spores within one hour, and staphylococci in from ten to fifteen minutes.

Traugott's[2] results indicate that 1 per cent. solution of hydrogen peroxid destroyed the bacillus of typhoid fever and of diphtheria in five minutes; cholera germs and the streptococcus of erysipelas, in two minutes; Staphylococcus pyogenes aureus in from fifteen to thirty minutes. This agent may, therefore, in the opinion of Traugott, be used instead of sublimate or carbolic acid, when it can have a longer time to act. When a rapid disinfection is required, as in the disinfection of the hands, it is inappropriate.

Gibier,[3] working with solutions containing 1.5 per cent. of hydrogen peroxid, destroyed within a few minutes B. anthracis, pyocyaneus, typhoid fever, cholera, yellow fever (?), megatherium, prodigiosus, osteomyelitis, and Streptococcus pyogenes.

Grandin[4] narrates the histories of cases of mammary abscess, suppurative pelvic haematocele, and puerperal endometritis, in which carbolic acid, sublimate solution, and tincture of iodin left him in the lurch, while suppuration or local sepsis ceased, and the patient went on to rapid recovery after the parts were washed out with undiluted hydrogen peroxid, or with it diluted in equal quantities of glycerin.

HYPOCHLORITES. (See CHLORID OF LIME, SODIUM HYPOCHLORITE, and ELECTROLYSIS.)

IATROL.

This is said to be obtained by a synthetical process from certain coal-tar derivatives, and to possess the combined properties of iodin, methylsalicylic acid, and phenol. It is a light, impalpable, almost odorless, white powder, readily soluble in alcohol, and slightly soluble in warm water and glycerin. The manufacturers claim that it is non-irritant and non-toxic. Dr. Theo-

1. Annali dell' Ist. d'Ig. dell' Univ. di Roma, II., 47. 1890.
2. Zeit. fur Hygiene, XIV., 440. 1893.
3. Medical News, LVII., 416. 1890.
4. The Times and Register—Centr. für Bak., IX., 769. 1891.

dore Deecke, of Utica, N. Y., carried out a series of bacteriological experiments for the purpose of testing the antiseptic value of iatrol. He found that it has decided antiseptic properties, but in the absence of published details relating to the experimental work, there is no ground for judgment as to the correctness of his conclusions. This name, "iatrol," should not be confounded with "itrol," mentioned under "Silver Salts."

INFLUENZA.

The researches of Pfeiffer[1] have established the fact that the bacillus of influenza is easily destroyed by adverse conditions. It is rapidly destroyed by desiccation. Disinfectants of extraordinary strength are not required. The disinfection of all secretions from the mouth, nose, bronchial tubes, and of all objects that have been in contact with the sick is important.

INSTRUMENTS.

The most trusted process for disinfecting surgical instruments is by subjecting them to moist heat,—steam or boiling water. We are told by some authorities that boiling water is equivalent to steam at 100° C. It is, however, more than equivalent in that it is more rapid and certain in its action. Some of the more resistant forms of pathogenic bacteria are supposed to be surrounded by protective envelopes which must be macerated and softened before the heat can penetrate their vital part. This is effected more rapidly with hot water than with steam. The protective coat in some bacteria in a dried state is believed to consist of a series of minute bubbles or molecules of air. Referring to this theory, Ihle[2] in a recent work, reminds us that gaseous or atmospheric bubbles are much more rapidly expelled from objects when they are in hot water than when in steam, due principally to the great difference between the specific gravity of water and of air on the one side, and the comparatively slight difference between that of air and steam on the other.

1. Zeit. für Hygiene, XIII., 357. 1893.
2. Eine neue Methode der Asepsis. Stuttgart. 1895.

With the late improvements in gas and petroleum burners, water in covered, enamel basins can very quickly be brought to the boiling point. When boiling water is the sterilizing agent, rusting of the instruments is usually prevented by the addition of about a teaspoonful of bicarbonate of soda to a quart of water. We are cautioned by Ihle[1] to have more soda in the solution for the sterilization of knives rather than too little; for solutions stronger than 1 per cent. have no unfavorable action upon cutting instruments. The smaller per cent. of soda fails to prevent knives from rusting. In sterilizing instruments by boiling, Levai[2] recommends the addition of from ¼ to 1 per cent. of caustic soda instead of the usual bicarbonate. So far as these processes are applicable, disinfection by boiling or with steam is preferable to the use of chemical agents.

Carbolic acid has been widely used as a surgical antiseptic and disinfectant. Upon the recommendation of Scheurlen,[3] certain surgeons have used a ½ per cent. solution of ortho-cresol, with 12 per cent. of common salt, as a very satisfactory antiseptic. The rusting of instruments in it can be prevented by the addition of 1:1,000 of hyposulphite of sodium. The preponderance of opinion among investigators is that the cresols, lysol, and solutol are more rapidly active when applied to pus-producing, and most other bacteria, than carbolic acid.

Lysol has the disadvantage in surgical work of rendering instruments slippery. This is, of course, overcome if they are subsequently washed in sterilized water.

Solveol, prepared as a surgical antiseptic, does not render instruments slippery, and is said to be more efficient than carbolic acid. (See Solveol.)

The field of use of mercuric chlorid is a very restricted one for the reason that it tarnishes instruments. According to Viquerat,[4] mercuric iodid has the advantage for this purpose over mercuric chlorid in that it does not tarnish instruments so quickly. With solutions of 1:1,000 of each, mercuric iodid does not begin to act generally before ten minutes, while the action of mercuric

1. Archiv für klinische Chirurgie.—Centr. für Bak., XVII., 919. 1895.
2. Jahresbericht über die Forstschitte u. Leist. auf dem Gebiete der Hyg. XIV., 278. 1897.
3. Archiv für Exper. Pathol. u Phar., XXXVII., 74. 1896.
4. Centr. für Bak., V., 585. 1889.

chlorid begins in one minute. In one hour, instruments that have been laid in mercuric chlorid have become black, while in mercuric iodid, in the same length of time, they have a yellowish coating that can be removed by a simple wiping.

Dr. Deniges[1] has combined Marechal's suggestion that instruments may be protected from rust indefinitely by the addition of a small quantity of some alkali with the use of a powerful antiseptic, and announces that instruments thus treated are absolutely sterilized, while they suffer no injury, even if left for months in the antiseptic solution. His formula is, mercuric cyanid two to five grams in one litre of water, to which is added five grams of sodium borate or carbonate.

The experiments of Dr. Chas. T. McClintock indicate that the "germicidal" soap devised by him is a rapidly efficient surgical disinfectant and does not tarnish instruments, although containing a mercurial salt. His opinion is confirmed by the work of Dr. F. G. Novy, and that of Dr. W. M. L. Coplin.

Experiments that have been carried out during the last few years indicate that formaldehyde, as a gas and in solution, will prove a very convenient and efficient disinfecting agent for surgical instruments. (See Formaldehyde—*Surgical Instruments.*)

For the disinfection of syringes, Hofmeister gives the following directions: The piston should be drawn from the cylinder and the lubricating material which came from the manufactory should be removed with ether or benzine (petroleumäther). The syringe should then be laid in a 2 to 4 per cent. solution of formalin for twenty-four hours. The formalin is generally all removed by rinsing, and the syringe is then ready to be disinfected by boiling, care being taken previously to expel the air both before and back of the piston. Syringes should be such as consist only of metal, glass, and leather.[2]

For the disinfection of sponges, Saul[3] recommends the use of 30 per cent. boiling propyl alcohol. Anthrax spores were destroyed in ten minutes. Fats and albumen did not interfere with the action.

---

1. Jr. Amer. Med. Asso.—Therap. Gazette, XXI., 783. 1897.
2. Jahresbericht über die Fortschritte u. Leist. auf dem Gebiete der Hyg., XIV., 278. 1897.
3. Archiv f. Klin. Chirurgie.—Münch. M. Woch., XLV., 759. 1898.

IODIN TRICHLORID.

Behring[1] says that this is the most efficient and many-sided of all the disinfectants. In another work[2] he says that, beside iodin trichlorid, only corrosive sublimate, carbolic acid and cresol with acids, the halogens, and cholrid of lime, among the agents tested are capable of destroying anthrax spores in a short time. It may also be classed among the safe disinfectants, as it is poisonous only in a minor degree. Threads of bouillon with anthrax spores were sterilized in from two to four minutes with 1 per cent. of iodin trichlorid. Even in blood, where acid solutions of carbolic acid or cresol, and solutions of mercuric chlorid leave us in the lurch, this agent is efficient. In serum, anthrax spores on threads were devitalized in five minutes with 2.5 per cent. of iodin trichlorid, and in from thirty to forty minutes with 1 per cent. Behring recommends a 5 per cent. solution as a convenient stock solution that will keep unchanged for weeks.

In the laboratory of the Imperial Board of Health of Germany, iodin trichlorid was subjected to a detailed investigation by Riedel[3] for the purpose of determining its antiseptic and disinfectant powers. The test-organisms being on threads, a 1:1,000 solution invariably destroyed anthrax spores in nine hours, anthrax bacilli in thirty minutes, Staphylococcus pyogenes aureus, in fourteen minutes, and staphylococcus of osteomyelitis in one hour. In bouillon, anthrax bacilli were killed in from eight to ten minutes with 1:1,000; staphylococci in from ten to thirty minutes with 1:4,000; and the cholera germ in from one half to one minute with 1:2,000.

Tested as a surgical antiseptic, iodin trichlorid in a solution of the strength of 1:1,200 prevented the growth of staphylococci, streptococci, the most important bacteria of surgical diseases, while a 1:1,600 was not certain in its effects. His experiments also showed that a complete sterilization of the hands may be effected with a 1:1,000 solution of iodin trichlorid after they have been cleansed one minute with warm water, soap, and nail-brush. Riedel concludes that iodin trichlorid is an

1. Bekampfung der Infectionskrankheiten, II., 27. 1894.
2. Zeit. für Hygiene, IX., 455. 1890.
3. Arbeiten a. d. Kais. Ges., II., 466. 1887.

efficient disinfectant and that its germicidal power is very much greater than that of carbolic acid and is surpassed only by that of corrosive sublimate.

After investigating iodin trichlorid, Tavel and Tschirch[1] report that this salt acts very energetically upon Staphylococcus citreus, S. pyocyaneus, and anthrax spores. With the last micro-organism it is superior to chlorin. The time of the action upon the bacteria was limited by the use of sodium thiosulphate solution. As a disinfectant, it makes no difference whether pure or the impure iodin trichlorid of commerce is used.

Rideal, referring to iodin trichlorid, says: "It is well known in organic chemistry that the presence of a trace of iodin favors greatly the action of chlorin on organic bodies, hence it is not improbable that a small quantity of iodin, or of its chlorid, might be a valuable adjunct to chlorin disinfection.[2]"

Traugott[3] says of iodin trichlorid that a 5 per cent. solution keeps for months without any susceptible change, but that a 1:1,000 solution rapidly loses its disinfecting power. According to his experiments, the germs of typhoid fever, cholera, diphtheria, streptococcus of erysipelas, Staphylococcus pyogenes, and staphylococcus from osteomyelitis were all destroyed within one minute with a 1 per cent. solution, and were all destroyed in from one to ten minutes with a 1:1,000 solution. Diarrheal discharges, with the addition of typhoid fever and cholera bacilli mixed with an equal volume of a 2 per cent. solution of iodin trichlorid, were disinfected in fifteen minutes.

IODOFORM.

The question of the antiseptic power of iodoform has called out much discussion. The favorable evidence derived from surgical practice has not been confirmed by the results obtained by many of the bacteriologists. Some light has, however, been thrown upon the rationale of the antiseptic and therapeutic action of iodoform by the work of some of the investigators. With the discovery of Scheurlen in mind, that the influence of

1. Centr. für Bak., XIII., 735. 1893.
2. Disinfection and Disinfectants, p. 74. 1895. London.
3. Zeit. für Hygiene, XIV., 444. 1893.

some of the ptomaines is to excite suppuration, and that this is particularly true of cadaverin, Behring's[1] experiments taught him that iodoform prevents cadaverin suppuration. He injected a concentrated solution of cadaverin subcutaneously and thereby produced suppuration. When pure cadaverin is added to iodoform, it is decomposed even in the cold. At the same time the iodoform is decomposed and free iodin is liberated. When cadaverin and iodoform in excess are simultaneously administered subcutaneously no suppuration results. A large part of the beneficial action of iodoform is due to the destruction of the cadaverin molecules. Assuming that the pathogenic action of virulent pus is not due merely to the presence of the bacteria of suppuration, but also to the chemical products themselves; and assuming, further, that these chemical products are influenced in a similar manner as cadaverin is influenced, it becomes evident that the curative action of iodoform in virulent suppuration may be exerted without direct harm to the micro-organisms of suppuration. Writing at a later date of the action of iodoform, he says, that it exerts its antiseptic action only when it is decomposed, and that from a surgical point of view this is a fortunate peculiarity of this agent. "Bacteria which have strong reducing characteristics decompose iodoform and render it active. * * * * * The more foul the secretions from the surfaces of wounds, the more vigorously it acts. * * * * * Iodoform is an antiseptic agent in the true sense of the word."[2]

The experiments of Mattei and Scala[3] confirm the results obtained by Behring, and teach them that, when iodoform or iodol comes in contact with certain reducing substances, iodin is liberated, and to this element in its nascent state is to be ascribed the antiseptic action of iodoform. They found that iodoform acts more energetically than iodol.

In an editorial in one of our leading medical journals[4], a brief review was given of the work of Lomry at the Löwen University. He found that, in experimental wounds upon the opposite sides of animals, in every case the iodoform gave to the wound to which it had been applied a red, healthy appearance which

1. Deutsche Med. Woch., XV., 837. 1889.
2. Bekampfung der Infectionskrankheiten, II., 102-106. 1894.
3. Bulletin d'R. Acad. Med. di Roma.—Centr. für Bak., V., 492. 1889.
4. Medical News, LXX., 54. 1897.

was lacking in the wound on the opposite side. The iodoform reduced the amount of secretions, increased the diapedesis of the white blood corpuscles, and did not diminish their vitality, as shown by their ameboid movements. It also delayed the development of the microbes. In laboratory tests with gelatin, agar, and bouillon cultures, they found, just as others had found, that iodoform had practically no effect in delaying the growth of bacteria. The surface of a wound does not present the same conditions as does nutrient gelatin in a test-tube. In the wound it is soluble, hence its antiseptic action. It is insoluble in gelatin, agar, and bouillon, and in these culture media it is inert. In serum, however, derived from various animals and in the fluid from hydroceles, blisters, pleurisy, and abscesses in man, the cultures in these media grew much less rapidly when iodoform was added. It may be stated, therefore, that the natural course of infection in a wound may be hindered by iodoform in three ways: by limiting the development of the microbes; by lessening their virulence; and by neutralizing their toxins.

LIGHT.

In the study of the available means of destroying infection, light, and, particularly, direct sunlight should not be forgotten. The researches of recent years show that sunshine has a degree of germicidal value; and the bacteriologist who is not mindful of this fact may obtain very misleading results. Twenty years ago, Downes and Blunt observed that diffused daylight retarded the putrefaction of organic infusions, and that direct sunlight absolutely inhibited putrefaction. Their work, done before the days of pure cultures, did not receive the attention which the importance of the subject deserved. It was not until the present decade that general attention has been directed to the subject. It is found that the most resistant of pathogenic organisms may, under favorable conditions, be destroyed by the action of sunlight.

Arloing observed that anthrax spores lost their power of development after two hours' exposure to sunlight; but to prevent the further growth of the anthrax bacillus in its vegetative form, twenty-seven or twenty-eight hours of sunshine were

required. Roux also observed that anthrax spores in bouillon, when freely exposed to the action of the air as well as that of light, were destroyed; but that the vegetative forms were still capable of development.

In 1890, Pansini published the results of his experiments to determine the action of sunlight upon B. anthracis, prodigiosus, pyocyaneus, violaceus, murisepticus, cholera, and Staphylococcus albus. He found that even diffused light had a marked effect in inhibiting the growth of bacteria after it had acted from twenty-four to forty-eight hours. Direct sunshine acting perpendicularly upon the surface of the cultures sterilized them all within one day. When the sunshine acted obliquely, it was necessary to expose the cultures several days in order to sterilize them completely. In liquid cultures from one half to two and one half hours sufficed to destroy all of the bacteria.

The observations of Marshall Ward[1] showed him that anthrax spores are destroyed in a few hours by the action of sunlight. Transferred to fresh culture media, it was shown that, instead of a delayed development, their destruction was complete. Electric light had a germicide action weaker than that of sunlight.

In the experiments of Momont,[2] anthrax bacilli without spores, in dried blood, resisted the action of sunlight and air eight hours. Anthrax bacilli from bouillon, dried and then exposed to sunshine live about five and one half hours. Anthrax spores resist the action of sun and air more than one hundred hours when dry. In pure water they are not killed by the action of the sun in one hundred and ten hours in the absence of air; but are destroyed by forty-four hours' exposure to the action of the sun and air.

Sirena and Alessi[3] experimented with the view of determining the action of desiccation and of light upon various bacilli under various conditions.

The bacillus of cholera dried in a dry room in the shade, or in sunshine exposed to air, or in sunshine hanging freely in the

1. Centr. für Bak., XIII., 568. 1893.
2. Annales de l'Inst. Past., VI., 21. 1892.
3. La Riforma Med., 1892.—Centr. für Bak., XI., 484. 1892.

room, was destroyed in one day; but dried in a moist room, vitality was retained twelve days.

Typhoid bacilli retain their vitality sixty-four days in a dry room in the shade, sixty-eight days dried in a damp room, one day exposed to the sunlight and enclosed in a reagent glass. and seven days when exposed to sunshine and hanging free in the room.

Anthrax bacilli containing spores were not killed in 431 days when dried in a dry room in the shade; but they were destroyed in 290 days in a damp room, in nineteen days when exposed to the sunshine in the reagent glass, or in forty-eight days when exposed to the sun and the air.

The conclusions of the authors are that desiccation is a powerful means of disinfecting; that the varying effects of desiccation are due in part to the bacteria themselves and in part to the conditions in which the desiccation occurs; that sunlight itself is capable of destroying the most resistant micro-organisms.

Typhoid Bacilli.—In a paper on the action of light upon bacteria, Geisler,[1] of St. Petersburg, refers to some of the works of his predecessors. Uffelmann noticed no injurious action of sunlight upon typhoid bacilli. Georges Gaillard, on the other hand, convinced himself that the action of direct sunlight, for from three to four hours, sufficed to destroy completely typhoid bacilli. He came to the following conclusions: The rapidity of the action of the light depends upon the medium in which the bacteria are; the action of light is greater when the atmospheric air has free access to the cultures; all parts of the solar spectrum have an action upon bacteria, but none so great as that of white light.

Janowski experimented with typhoid bacilli. He came to the conclusion that light has a direct action upon bacteria irrespective of any chemical changes in the culture media. Typhoid bacilli exposed to direct sunshine were nearly all destroyed in from six to ten hours. Diffused light had a germicide action, though weaker.

Referring to the results of his own experiments, Geisler concludes that, a qualitative difference between the action of sunlight and electric light could not be observed, but the inhibitive

1. Centr. für Bak., XI., 161. 1892.

action of sunlight upon the development of typhoid bacilli is distinctly greater than that of electric light.

Not only the light and the chemical rays of electric light and sunlight act injuriously upon the growth of typhoid bacilli, but the heat rays have an auxiliary action in the same direction. All of the rays of the electric and solar spectrum, with the exception of the red rays, inhibit the growth of typhoid bacilli.

The unfavorable action of the electric light and sunshine upon the growth of typhoid bacilli on gelatin is due, not only to the direct action of the light upon the bacilli themselves, but depends also in some measure upon changes in the culture media.

Dieudonné found that the bacillus of typhoid fever and B. coli were destroyed in one and one half hours' exposure to the action of the sunshine.

Cholera.—In a first series of experiments, Palermo[1] used bouillon cultures of cholera three days old as the most virulent. Tubes of 10 cc. were used. While exposed to the action of the sun, precautions were taken against undue elevation of temperature. In a second series, from 3 to 6 cc. of the culture were diluted with 30 cc. of sterilized distilled water. The results obtained by him indicate: that even after an exposure of six or seven hours to the action of the sunshine there was no diminution in the number of bacilli, but their restricted motion indicated an attenuation of biologic functions; that a comparatively shorter exposure to the action of the sun,—three or four hours, —sufficed to deprive the germs of virulence when tested on guinea-pigs; that the diminution of virulence is effected more rapidly when the media are diluted.

The results obtained by Buchner did not agree with those obtained by Palermo. He found that light has a very powerful disinfecting action upon aqueous suspensions of cholera spirilli.

Tuberculosis.—In the experiments of Dr. Migneco,[2] of the University of Catania, he found that, after ten or fifteen hours' exposure to sunshine, the bacillus of tuberculosis gradually lost its virulence, giving rise on inoculation to localized tuberculosis, and that, after twenty-four to thirty hours' exposure, complete

1. Annali dell'Ist. D'Ig. Sperim. della R. Univ. di Roma, III., (Nuova Serie), 463. 1893.

2. Annali D'Igiene Sperimentale, V., 216. 1895.

sterilization was effected. The material used by him was tubercle sputum containing tubercle bacilli smeared on cloth.

Before the International Medical Congress held in Berlin in 1890, Koch stated that the bacillus of tuberculosis is killed by the action of direct sunlight in from a few minutes to several hours, depending upon the thickness of the layer exposed. Diffused daylight has the same effect, but acts more slowly.

Ransome and Delépine made a series of investigations with the object of determining how short a period of exposure to air and light would suffice to destroy the virulent action of the bacillus of tuberculosis.

The experiments were made with both pure cultivations and with dried sputum, in some cases scraped and reduced to dust. Guinea-pigs were used for the inoculations. The experiments with the dried sputum are the most interesting, as they conform most closely with what would be met with in practice. The specimens were exposed for short periods only—two, three, and seven days—though control specimens were kept for long periods of time in darkness, and with very slight access of air. It was observed that in all the specimens exposed in the dark, tuberculosis was the result even in free currents of air. All the specimens exposed to both air and light, even for two days only, and for one hour of sunshine, were found to have entirely lost their power for evil. Specimens of the same tuberculous dust gave tubercle to guinea-pigs after it had been kept in the dark, and with very little air, for thirty-five days.[1]

Diphtheria Bacillus.—In the experiments of Piazza,[2] the action of sunlight is shown to attenuate the virulence of diphtheria toxin, slowly when the air is excluded, and much more rapidly when air is admitted.

In the work of Ledoux-Lebard,[3] it was found that sunshine has a distinct germicide action upon the bacillus of diphtheria, but that in his opinion sunshine can be depended upon only as an auxiliary to other methods of disinfecting in this disease.

Bacteria of Suppuration.—The results obtained by Chemelewsky[4] were as follows: When subjected to the action of

1. Public Health, Vol. VII., 131. 1895. London.
2. Annali D'Igiene Sperimentale, V., 521. 1895.
3. Revue D'Hygiene,, XVI., 69. 1894.
4. Vrach.—Centr. für Bak., XII., 174. 1892.

electric light for six hours the development of the bacilli of suppuration was checked. When the same bacilli were subjected to the action of sunshine for the same length of time they were destroyed. Not only the chemical and light rays, but the heat rays retard the development of bacteria. The development of Staphylococcus pyogenes albus, bacillus pyocyaneus, streptococcus erysipelatos, and S. pyogenes is retarded by all the rays of the spectrum with the exception of the infra-red rays. Staphylococcus pyogenes aureus proved the most resistant. The results showed that the virulence of bacteria of suppuration is diminished under the influence of light.

How Light Acts.—The suggestion has been made that the germicide action of sunshine is due to its heat rays. Santorni,[1] however, investigated the simultaneous action of sunshine and the resulting heat from it. He found that the germicide action of sunshine was distinct when the accompanying temperature was not high; that bacteria when dry withstand the action of light much longer; that no great difference exists between the power of anthrax spores and anthrax bacteria to withstand the action of the light; that the higher the accompanying temperature, the greater the effect of sunshine or the electric light; that the action of an electric light of 900 candle power is distinctly weaker than that of sunlight.

Marshall Ward's[2] experiments demonstrated that the actinic rays of the sun, independent of the heat, act germicidally. Kruse[3] also determined the fact that the disinfecting action of light is not due to the heat rays, but that the higher the accompanying temperature the greater the germicide action of the light.

The noxious action of light upon bacteria has also been ascribed to changes in the medium in which they are found.

In 1893, Richardson communicated his observation that, when fresh urine was exposed to the action of direct sunshine and air, there was invariably a formation of hydrogen peroxid which resulted in the destruction of the bacteria. Urine thus exposed to the action of the sunlight even showed an antiseptic action

1. Quoted by Geisler.
2. Lancet, II., 1893, 383.
3. Zeit. für Hyg., XIX., 323. 1895.

when added to other urine that was putrefying and had not been exposed to the action of the sunshine.

Dieudonné[1] undertook a series of experiments for the purpose of determining the truth of this, and whether the sunshine also had a similar action upon other culture media. He found that, when exposed to the action of the light, hydrogen peroxid is formed in agar and gelatin cultures in sufficient quantities to exert an antiseptic action.

This action is due to the blue and violet rays. The red and yellow rays have no action of this kind.

Hydrogen peroxid thus formed is rapidly decomposed when removed from the light. When the culture is again brought to the light, there is a re-formation of hydrogen peroxid. This can be repeated indefinitely with the same results. He furthermore found that light had the same action upon ordinary water, —formation of hydrogen peroxid.

In the different strata of water exposed to the action of light the quantity of hydrogen peroxid was unlike. It was most plentiful in the upper portion of the water.

As to the manner in which sunshine exerts its bactericide action, this observation that light, in certain culture media and fluids, gives rise to the formation of hydrogen peroxid offers at least a partial explanation.

In polluted water no reaction indicative of the presence of hydrogen peroxid is at first obtained, for the reason that hydrogen peroxid, as fast as it is formed, is decomposed in its action upon bacteria.

Further experiments by Dieudonné showed that, in the absence of oxygen, there is no formation of hydrogen peroxid. The experiments were made with various anaerobic bacteria.

The formation of hydrogen peroxid through the action of air and light appears, therefore, to constitute a not unimportant factor in the germicide capabilities of light. The self-purification of rivers which, according to the investigations of Buchner, is to be ascribed largely to the action of light, receives a partially satisfactory explanation in the fact that hydrogen peroxid is formed under the influence of light.

1. Arbeiten a. d. Kais. Ges., IX., 537. 1894.

Dandrieu[1] made a series of experiments which showed the part played by oxygen in the germicide action of light. In two flasks, one red and one clear, Dandrieu exposed dilute sewage to the action of the sun. The oxygen content of the water, before its insulation, was 5.6 mg. per litre; after it had been exposed to the action of the sunshine, there was a diminution of the oxygen in the red flask and a great increase in the water enclosed by clear glass.

	Oxygen before insulation.	Oxygen after insulation.	
		8 days.	14 days.
Red flash......	5.6	3.6	2.46
Clear flask	5.6	17.92	23.96

In the water from the red flask, the bacterial flora was exceedingly rich, there being innumerable motile bacilli, vibrioni, and zöospores present; in the water from the clear glass there were only cocci present. Dandrieu concludes that, under the influence of sunlight, micro-organisms develop which have a reducing action on carbon dioxid, and that the oxygen thus liberated destroys bacteria.

As has been noted, Geisler found that light has a direct action upon bacteria, but that this action depends in some measure upon changes in the culture media.

Kruse has shown that the intensity of the action of light upon bacteria depends upon the access of oxygen, and that while light has a direct germicide action the chemical changes in the media or the liquids in which bacteria are suspended are an important factor in the work.

Sewage, and the Self-Purification of Rivers.—With the view of determining to what extent the action of the sun can be depended upon to disinfect sewage, and what part light plays in the self-purification of rivers, Procaccini[2] carried out a series of investigations. The tables which he presents indicate that the action of the sunlight is strongly bactericidal. Sewage was

1. Annales d'Hyg.—Centr. für Bak., V., 186. 1889.
2. Annali dell'Ist. D'Ig. Sper. della R. Univ. di Roma, III., (Nuova Serie) 437. 1893.

exposed in glass vessels of a height of 60 cc. and a diameter of 25 cc. Selecting one experiment as a typical one, the number of colonies was reduced from 5,401 to 4 after six hours' exposure to the sunlight, while, in the duplicate experiment, the number of colonies increased from 5,493 to 9,419 in five hours, and to a much larger number in six hours. The two vessels were kept at practically the same temperature.

In experiments to determine the depth to which the action of the sun was exerted, the cylinders were protected from all but the perpendicular rays. After three hours' exposure there were nine colonies at the top, ten at the center (30 cc. deep), and 2,115 at the bottom of the column of sewage (60 cc. deep). In a control experiment, in which the cylinder was protected from the sun, the numbers in the same order were 3,103, 3,021, and 3,463.

Professor Buchner[1] sought to determine the influence of light upon the bacillus of typhoid fever, B. coli communis, B. pyocyaneus, cholera spirilla, and various bacteria of decomposition. He found that when these bacteria are suspended in water, light has a very powerful disinfecting action. For instance, water containing 100,000 B. coli communis per cc. is rendered completely sterile by one hour's exposure to direct sunshine. Control samples kept at the same temperature, but not exposed to the light, showed a slight increase in the number of bacteria.

Even diffused daylight effected a marked diminution in the number of germs after one hour's exposure. He believes that the action of light plays an important part in the self-purification of the water of rivers and lakes, although he alludes to the fact that certain species of bacteria are not prejudicially affected by the action of light.

In another paper by Professor Buchner,[2] referring to light as an important factor in the self-purification of rivers, he says that, even in September and November, diffused daylight sufficed to destroy, in five hours, bacillus of typhoid fever, B. pyocyaneus, and B. coli.

1. Centr. für Bak., XI., 781. 1892.
2. Archiv für Hygiene, XVII., 179. 1893.

The Influence of Light upon the Animal Organism.—A series of experiments carried out by Dr. Masella[1] for the purpose of determining the influence of direct sunshine upon guinea-pigs inoculated, some with the bacillus of typhoid fever, and some with that of cholera, showed in both series of animals that their resistance against the action of the injections was diminished by exposure to direct sunshine, irrespective of the heat rays of the sun.

Arnould,[2] referring to these experiments which indicate that sunlight lessened the resistance of these animals to infection, is but little disposed to admit the opinion that sunlight is so important a factor of morbidity and of mortality. He finds that the number of experiments made by Masella was too small to have great value, and he thinks, furthermore, that he did not eliminate fully enough the influence of temperature.

Arnould admits that sunshine occupies only a secondary place among the conditions which favorably influence human vitality. He believes that the indirect action,—the action in destroying and preventing the development of the morbific germs,—is the principal value of light as an essential element in individual health.

The Real Value of Light as a Disinfectant.—Esmarch[3] refers to the fact that Boubnoff has shown that the chemical action of the rays of the sun extends more or less deeply into fabrics, but it seemed to Esmarch that it was necessary to determine whether the direct sunlight may be used as a means of disinfecting certain things, as cushions, mattresses, and upholstered furniture, which in many places cannot be subjected to other trustworthy processes of disinfection. His experiments show that the direct rays of the sun, under certain conditions, penetrate considerably below the surface of the articles to be disinfected. The action of the sun penetrated layers of linen cloth and destroyed cholera bacilli in from one to two hours upon the second and fourth layers of the cloth. To obtain the same effect with diphtheria cultures upon the first and third thicknesses of linen or of white wollen cloth, five hours' exposure to the direct sunshine was required. Staphylococcus pyogenes aureus, or Streptococcus

1. Annali D'Igiene Sperimentale, V., 73. 1895.
2. Revue D'Hygiene, XVII., 511, 668. 1895.
3. Zeit. für Hygiene, XVI., 257. 1894.

pyogenes was destroyed with no certainty after six hours' exposure. The light penetrated dark colored cloths much less deeply, and destroyed bacteria much less readily than in the case of white fabrics.

In the interior of cushions, prolonged exposure to the action of the sun was powerless to destroy the diphtheria bacillus. These and other experiments convince Esmarch that in the action of the sunlight we have no trustworthy means of disinfecting. When we can assume that the pathogenic germs are upon the surfaces of articles, as in most cases of diphtheria, it would suffice to expose the articles to the action of the sun for a few hours, but when, in cases of cholera or typhoid fever, the dejections of the patient may have penetrated to the interior of mattresses, the action of the sunshine cannot be trusted.

For the purpose of comparing the action of the sunlight upon upholstered articles with that of spraying with carbolic acid, he carried on a series of experiments with the latter disinfecting agent. His results obtained with a 2 per cent. solution were untrustworthy, but with a 5 per cent. solution of carbolic acid, and spraying it plentifully over the surfaces of the goods until their surfaces were completely wet, the results were somewhat better, though not very encouraging.

Dieudonné[1] says that, unfortunately, sunlight acts only upon the surface of matter to be disinfected; therefore, for clothing, bedding, etc., it is not a trustworthy means of disinfection. It is, nevertheless, a hygienic factor which should not be underestimated.

Kruse[2] refers to sunshine as a universal and the cheapest means of disinfecting our houses and their surroundings, but at the same time, speaks of its limitations as a disinfecting agent. About and within our houses it must have access in the greatest abundance, but the attendant heat and ocular irritation are often objectionable. In the disinfection of furniture, for instance, the difficulty of having direct sunshine gain access to every part is apparent. As to the action of light upon the bacteria of rivers or other bodies of water, it can be shown experimentally that it is not uniformly trustworthy. Its failure

1. Arbeiten aus dem Kais. Ges., IX., 405. 1894.
2. Zeit. für Hygiene, XIX., 332. 1895.

to sterilize is due sometimes to the slight intensity of the light, sometimes to turbidity of the water, and the absence in the water of a sufficient quantity of oxygen may contribute to the failure.

The experiments of Procaccini, already cited, show that, in their action upon sewage, the disinfecting rays of sunlight do not penetrate to any great depth below the surface.

LIME (CAUSTIC LIME, CALCIUM OXID).

In 1887, Liborius[1] published a paper giving the results of his experiments with quick, or caustic lime to determine its disinfecting power. He sums up his results in the following words:

"A watery solution of lime of the strength of 0.0074 per cent. is sufficient to destroy typhoid bacilli in a few hours, and in the proportion of 0.0246 per cent. it will disinfect cholera bacilli in the same length of time.

"Cultures of the cholera bacillus in unfiltered bouillon containing abundant albuminous precipitate, which offer at least as unfavorable conditions for the action of the disinfectant as are present in natural cholera dejections, are completely and permanently disinfected in the course of a few hours by the addition of 0.4 per cent. of pure quicklime, or by 2 per cent. of crude burnt lime in fragments.

"Under more difficult conditions the most energetic action of the lime was obtained when it was used in the form of pure, pulverized, caustic lime, or as a milk of lime containing 20 per cent. of the same."

To test the conclusions of Liborius, Sternberg[2] made a somewhat extended series of experiments. He says:

"The above experiments suffice to demonstrate the fact that pure calcium oxid has no great value for disinfecting purposes, and show that the proposition of Liborius to give it the preference over chlorid of lime on account of its comparative cheapness is based upon a misconception of the *practical* value of the two agents for disinfecting purposes. Inasmuch, however, as calcium oxid has considerable germicide power when used in the form of lime-wash, especially after prolonged contact, the

1. Zeitschrift für Hygiene, II., 15. 1887.
2. Disinfection and Disinfectants, p. 172. 1888. Concord.

general use of lime-wash for sanitary purposes is to be recommended wherever it can be applied to surfaces which are supposed to be infected by disease germs."

Kitasato[1] concluded from his own experiments that the typhoid bacillus is destroyed in nutrient gelatin and in bouillon by the addition of 0.0966 per cent. of lime, about thirteen times the proportion found by Liborius to be necessary. This difference he deems to be due to the fact that Liborius diluted his bouillon with fifteen times its quantity of sterilized distilled water, while he used his culture media undiluted.

Cholera bacilli were disinfected with caustic lime in the proportion of 0.1 per cent. against 0.0246 per cent. as given by Liborius.

Liborius and Kitasato having determined the minimum quantity of caustic lime to be used for the destruction of typhoid and cholera bacilli, Pfuhl[2] set himself the task of learning in what quantity and in what form it is best to use caustic lime for the disinfection of typhoid and cholera stools. His experiments taught him that the action of the lime, when added in fragments to liquids to be disinfected, is slow and uncertain. When to the quicklime, as obtained in the market, one half its weight of water is added, it is slaked to a dry powder. If the hydrate of lime thus resulting is added in the form of powder to typhoid dejections, the powder has a tendency to collect in masses and not mix uniformly with the matter to be disinfected.

Pfuhl found that the best way to use the lime is in the form of milk of lime made by the addition of one part of caustic lime to four parts of water, and thoroughly mixing. This gives a 20 per cent. mixture. Two per cent. of this milk of lime added to neutral typhoid discharges disinfected them completely in one hour.

He therefore concludes that, in practice, it is best to add to the matter to be disinfected 2 per cent. by volume of the 20 per cent. milk of lime.

It is self-evident, he says, that the addition of 2 per cent. of the lime-wash will be sufficient only when it is prepared from lime of good quality, and when used soon after its preparation,

1. Zeitschrift für Hygiene, III., 416. 1887.
2. Zeitschrift für Hygiene, VI., 98. 1889.

or at least within a few days, having in the meantime been excluded from the atmosphere, and when the typhoid or cholera dejections, as is the rule, are of a liquid consistency.

According to his experience, it is sufficient in the disinfection of excreta to add the milk of lime until every portion of the matter to be disinfected gives a distinct alkaline reaction, that is, until red litmus paper is colored a deep blue when a drop of the mixture on a glass rod is touched to it.

The results obtained by Liborius, Kitasato, and Pfuhl were so unexpected, and their practical application, if correct, would be of so much value in practice, that Richard and Chantemesse[1] thought it worth while to repeat the work of their predecessors. They tested the comparative disinfecting power of lime, using Pfuhl's 20 per cent. milk of lime, and, for purposes of comparison, a solution of corrosive sublimate 1:1,000 with five per cent. of hydrochloric acid added, and a 5:100 solution of chlorid of lime.

As matter to be disinfected, they used typhoid and dysenteric stools in flasks, sterilized with heat, inoculated with typhoid bacilli or with the micro-organism thought by the authors to be the pathogenic agent of dysentery. Eight hours afterward the disinfectant was added and mixed with the pure cultures thus secured.

The typhoid bacilli were not destroyed in forty-eight hours by the corrosive sublimate solution, neither were they by the acid sublimate solution. They were not destroyed by the chlorid of lime solution in one hour. On the other hand, the milk of lime effected complete disinfection in half an hour.

The dysenteric stools were also thoroughly sterilized in half an hour by the milk of lime, while the acid corrosive sublimate solution failed to do it in twice that length of time.

There is unfortunately a discrepancy, apparently a mistake of the printer, in the statement of Richard and Chantemesse of the quantity of the disinfectant solutions used in comparison with that of the matter to be disinfected.

Schanz[2] also tested the disinfecting power of caustic lime and was able to confirm the results of Liborius, Kitasato and Pfuhl

1. Revue D'Hygiene, XI., 641. 1889.
2. Deutsche Med. Woch., XVI., 77. 1890.

as to its efficiency in the disinfection of liquids, but he doubts whether it would be suitable for the disinfection of excreta, on account of its lack of power to penetrate the more solid masses and particles of fecal matter.

Karlinski[1] gives his testimony also to the efficacy of lime as a disinfectant. Added to typhoid stools in the proportion of about 4 per cent., the bacilli were entirely destroyed within forty-eight hours.

The foregoing statement of the results of experimental work with caustic lime, or milk of lime, was made for the Fifth Annual Report. Since then some further work has been done and "milk of lime" has received wide recognition as a cheap and trustworthy agent for the disinfection of excreta.

In his experiments in the disinfection of stalls, cattle cars, etc., Jaeger[2] learned that the specific micro-organisms of chicken cholera, hog cholera, erysipelas of swine, typhoid fever, glanders, and sporeless anthrax bacilli and Staphylococcus aureus are killed in two hours by the action of a thick milk of lime applied with a brush once. On the contrary, lime-wash failed to destroy anthrax spores, and the bacillus of tuberculosis was not destroyed in six hours, though three applications of the milk of lime were made.

Giaxa[3] conducted a similar line of work, thereby determining that, in the disinfection of walls, even a 50 per cent. lime wash, acting forty-eight hours, failed to destroy anthrax spores, the bacillus of tuberculosis and the bacillus of tetanus. The typhoid and the cholera bacillus, sporeless anthrax bacilli, and Staphylococcus aureus, were destroyed, the cholera germ readily, and the staphylococcus with difficulty. He recommends whitewashing as trustworthy for only cholera and typhoid fever.

Beyer[4] carried out a series of experiments to determine whether lime water is an efficient and desirable disinfectant for clothing infected with the germs of cholera, typhoid fever, diphtheria, and with Bacterium coli and Staphylococcus pyogenes. aureus. In nearly all of his experiments, complete sterilization was attained in twenty-four or forty-eight hours. His conclu-

1. Centr. für Bak. und Par., VI.. 75. 1889.
2. Arbeiten a. d. Kais. Ges., V., 251-273. 1889.
3. An. de Mic.—Giornale della Reale Soc. Ital. D'Ig., XII., 345. 1890.
4. Zeit. für Hygiene, XXII., 228. 1896.

sions are that lime water is an efficient disinfectant for all these bacteria; but to insure complete sterilization, the clothing must be left in the lime water forty-eight hours, or to disinfect in twenty-four hours, the clothing must be washed in an excess of lime water and left in it a while, then be transferred to fresh lime water and soaked in that for twenty-four hours.

As to the effects upon fabrics, he found, by many experiments, that woolens suffer changes in color and texture, but that cottons and linens suffer practically no change in textile strength, elasticity, or color. Beyer, therefore, recommends lime water as an efficient as well as cheap disinfectant for cotton and linen goods.

Referring to his work in the disinfection of fecal matter, Vincent[1] states that his results with caustic lime were less favorable than those obtained by other experimenters. To destroy the bacillus of typhoid fever in twenty-four hours at the temperature of 15° C., a 25 to 30 per cent. milk of lime must be used. The comma bacillus in cholera stools is destroyed in seven hours at the same temperature with a 15 per cent. of milk of lime.

In comparing the action of milk of lime with that of saprol in the disinfection of excreta, Scheurlen[2] refers to Pfuhl's experiments which show that, when thrown into a vault containing fluid or semi-fluid matter, the milk of lime sinks to the bottom of the liquids and is only partially mingled with the contents of the vault unless they are stirred mechanically.

This mechanical mixing is practically impossible. Another objection to the use of milk of lime for this purpose is that the liquid contents of the vault are rich in substances which combine with the hydrate of lime, thus destroying its disinfectant properties. We have here, not only the fixed and volatile phosphates, carbonates, and sulphates of the alkalies, but we have to take into account the large quantity of carbonic acid which is produced by the decomposition of urea (which amounts to about 40 grams per head per day), uric acid, and other products.

Special Uses.—In the prevailing practice, milk of lime finds its most frequent use in the disinfection of excreta. For the disinfection of excretal matter in the sick-room, several quarts

1. Annales de l'Inst. Past., IX., 15. 1895.
2. Archiv. für Hygiene, XIX., 349. 1893.

of the milk of lime may be kept in a jug closely corked, in or near the room. Though in the opinion of Pfuhl, 2 per cent. of the 20 per cent. milk of lime suffices, the safer practice is to add to each stool a volume at least twice that of the discharge to be disinfected. As time is an important element in disinfection, each discharge thus treated should remain exposed to the action of the disinfectant ten or twelve hours, preferably, but three or four hours, at least, before the final disposition is made of it in the sewers or otherwise. Before each use of the milk of lime, the jug containing it should be shaken.

For the disinfection of fecal matter in vaults, the contents should receive a thorough saturation, and in the case of privies in which the earth forms the catch-basin, the ground beneath should be thoroughly saturated with the milk of lime. Even then, the disinfection can be assured only after a complete mixture of the disinfecting fluid with the matter to be disinfected. The quantity of milk of lime prescribed by Pfuhl for the vaults of military barracks is 400 cc. (about 1 pint) per man daily. For the same purpose Behring[1] says 5 to 7.5 litres daily for each 250 men. If the contents of the vault do not then give a distinct alkaline reaction with litmus paper, add more of the milk of lime until they do.

The rule adopted in the infectious disease hospitals in Hamburg is to mix the fluid excreta with lime and let it stand two hours before it is let into the sewers.[2]

Comparison with Other Agents.—For the disinfection of excreta and sewage, Behring[3] prefers caustic lime to chlorid of lime as being more convenient to use and for retaining its disinfecting powers better. The disinfecting power of lime, potash, and soda is equal when of the same degree of alkalinity. The Committee on Disinfectants of the American Public Health Association in 1885, showed a preference for chlorid of lime. Richard and Chantemesse had better results with milk of lime in the disinfction of excreta. For the same class of work Vincent ranks caustic lime lower than chlorid of lime. In his hands, copper sulphate was superior to either.

1. Zeit. für Hygiene, IX., 410. 1890.
2. Deutsche Viert. für off. Ges., XXVIII., (Sup.), 261. 1897.
3. Bekampfung der Infectionskrankheiten, II., 93. 1894.

Preparation.—Slake a quart of freshly burned lime in small pieces with three fourths of a quart of water,—or, to be exact, 60 parts of water by weight with 100 of lime. A dry powder of hydrate of lime results. To make milk of lime for ordinary use mix one quart of this dry hydrate of lime with four quarts of water.

Air-slaked lime is worthless. The dry hydrate of lime may be preserved some time if it is enclosed in an air-tight container. Milk of lime should be freshly prepared, but may be kept a few days if stoppered closely.

LITTLE'S SOLUBLE PHENYLE.

Hammer[1] states that this is a solution of cresol in soap, or by means of soap. (See Creolin.) The experiments of the Committee of the American Public Health Association show that it has considerable disinfecting power. It is an efficient deodorant. Rideal[2] says that "it appears to be derived from wood-tar creasote."

LYSOL.

Lysol is a preparation containing about 50 per cent. of cresol rendered soluble with neutral potash soap.

Fränkel, Behring, and Hammer are at variance as to whether lysol is alkaline. Heider says that there is no free alkali. As to its disinfecting power, Remouchamps and Sugg,[3] using typhoid and cholera bacilli as test-objects, found that, in the absence of albuminous matter, lysol was superior to carbolic acid, but when the liquids to be disinfected were albuminous, there was no appreciable difference in their action. For the sterilization of Staphylococcus pyog. aureus, Gruber[4] found a 2 per cent. solution of lysol as effective as a 3 per cent. solution of carbolic acid. Buttersack[5] also concluded that lysol destroys this staphylococcus more promptly than does carbolic acid. In his experience, lysol is more efficient than carbolic acid for the disinfection of

1. Archiv für Hygiene, XIV., 116. 1892.
2. Disinfection and Disinfectants, p. 176. 1895. London.
3. Mouvement Hyg.—Hyg. Rundschau, I., 436. 1890.
4. Centr. für Bak., XI., 117. 1892.
5. Arbeiten a. d. Kais. Ges., VIII., 369. 1892.

fresh tuberculous sputum. Lingelsheim, as quoted by Pohl, learned that streptococci are killed in fifteen minutes by a 0.5 per cent. solution of lysol, while to accomplish the same results in the same time with creolin, the strength of the solution must be 1.25 per cent. Pohl's[1] own judgment of lysol is that it is much more effective than carbolic acid or creolin. Behring[2] says that lysol cannot be classed with the disinfectants for spore-bearing bacteria, since he determined that anthrax spores are not killed in twenty-four hours with a cold solution. When, however, the solution is warmed to 40° or 50° C., its power is considerably increased.

Influence of Media.—Schottelius, as quoted by Behring,[3] could find no difference in the germicide action of lysol, whether tested on bacteria suspended in water, bouillon, or serum. Behring criticizes the methods of Schottelius and states that, in the experimental work at the Hygienic Institute in Berlin, it has been found that the action of lysol is diminished by the presence of albumen.

Excreta.—In the experiments of Vincent,[4] liquid diarrheal stools, or fresh fecal matter diluted with urine were disinfected in twenty-four hours with lysol 6:1,000 or 7:1,000. Only a few innocuous microbes persist. If the fecal matter is of greater consistence, or has undergone fermentation, 10 or 11 per 1,000 is required. This quantity is needed for privy vaults. The action of lysol is continuous: the number of bacteria diminish from day to day. The bacillus of typhoid fever was killed in fifteen minutes with a 0.5 per cent. solution. The cholera bacillus in cholera dejections requires 3.5 per 1,000 at 15° C. for sterilization in seven hours. Schottelius, as quoted by Laser,[5] recommends lysol particularly for the disinfection of excreta as more efficient than carbolic acid and creolin.

Tuberculous Sputum.—In the experiments of Buttersack,[6] lysol was shown to be a very efficient disinfectant for fresh tuberculous sputum, dissolving the albuminous masses and acting more promptly than carbolic acid.

1. Ein Beitrag zur Kentnis der dis. Eigenschaft des Lysols. p. 36. 1893.
2. Bekampfung der Infectionskrankheiten, II., 122. 1894.
3. Zeit. für Hygiene, IX., 420. 1890.
4. Annales de l'Inst. Past., IX., 26. 1895.
5. Centr. für Bak., XII., 232. 1892.
6. Arbeiten a. d. Kais. Ges., VIII., 371. 1892.

Surgical Uses.—As has been stated, Gruber found that a 2 per cent. solution of lysol destroyed the staphylococcus of suppuration as readily as a 3 per cent. solution of carbolic acid. For the disinfection of the hands, and for many other uses in surgical work, lysol has advantages over carbolic acid: it is probably a little more rapidly germicidal, it is less poisonous, and it is cheap. In Martin's clinic in Berlin, the statistical showing was more favorable after the use of lysol than after that of carbolic acid. In surgical work, Haenel[1] says that lysol has no unpleasant action upon the hands unless it is used in stronger solutions than 2 per cent. Gerlach,[2] speaking of the advantages of lysol in surgical practice, says that it is more efficient than carbolic acid; that the disinfection of the hands is assured by using a 1 per cent. solution without the previous use of soap; that a ¼ per cent. solution renders instruments sterile and does not attack the instruments; and that it is eight times less poisonous than carbolic acid and much less so than corrosive sublimate.

Dr. Vondergoltz[3] has used lysol and lakrol as antiseptics in obstetric practice with excellent results. Their detergent qualities also commend them to him.

Solutions of lysol have the disadvantage in surgical work of rendering the hands and instruments slippery. This can, however, be overcome by subsequent washing in sterilized (boiled) water. Under "Solveol" there will be some consideration of the question whether the combination of the saponaceous with the disinfectant property, as in lysol, is desirable.

Toxicity.—The general testimony is to the effect that lysol is less poisonous than carbolic acid. Remouchamps and Sugg[4] rate the toxicity of lysol as less than one sixth of that of carbolic acid.

Solutions and Uses.—There appears to be ample reason for regarding lysol as a very efficient disinfectant for all ordinary species of contagion,—for all sporeless bacteria. It forms comparatively clear solutions with water in every proportion, thus

1. D. M. Woch.—Centr. f. Bak., XI., 608. 1892.
2. Zeit. für Hygiene, X., 167. 1891.
3. N. Y., Medical Times, XXIV., 356. 1896.
4. Op. cit.

for many purposes having an advantage over creolin and carbolic acid.

For the disinfection of clothing, a 2 per cent. solution, preferably as hot as the hand will bear, or hotter, would apparently suffice. For the removal of blood stains and the disinfection of clothing at the same time, Heider[1] proved lysol to be better than potash, solutol, soft soap, soda, or solveol. For the disinfection of tuberculous sputum or fresh typhoid discharges, a 4 or 5 per cent. solution would be required.

MERCURIC CHLORID (CORROSIVE SUBLIMATE).

Beginning with the work of Koch, in 1881, the many series of experiments made for the purpose of determining the bactericidal power of corrosive sublimate have given very diverse results. In Koch's[2] hands, corrosive sublimate 1:1,000,000 perceptibly retarded the growth of anthrax bacilli, 1:300,000 completely arrested their growth, 1:20,000 destroyed anthrax spores in ten minutes, and a single moistening with a solution of 1:5,000 sufficed to kill the spores of the same bacillus in a few minutes. Dr. George M. Sternberg,[3] as Chairman of the Committee on Disinfectants of the American Public Health Association, says: "My own observations are in accord with those of Koch, Jalan de la Croix, and others, as to the power of this agent in dilute solutions (1:1,000 to 1:10,000) to destroy the spores of bacilli,—*B. anthracis* and *B. subtilis*,—and this constitutes the most difficult biological test known. Micrococci and bacilli in active growth, without spores, are killed by much weaker solutions (1:20,000 to 1:40,000)."

On the other hand, working with the 1:1,000 solution, Geppert[4] found that, with neutralization of the mercuric chlorid, anthrax spores are never destroyed in half an hour. Behring[5] states that an exposure of twenty-four hours is required, and Heider[6] had spores of the same bacillus which were alive after seventy-two hours' exposure to the solution.

1. Archiv für Hygiene, XV., 885. 1892.
2. Mittheil aus dem K. Ges. I., 269, 276. 1881.
3. Disinfection and Disinfectants, p. 41. 1888. Concord.
4. Deutsche Med. Woch., XVII., 1065. 1891.
5. Zeit. für Hygiene, IX., 447. 1890.
6. Arch. für Hygiene, XV., 357. 1892.

The marked discrepancy observed in the results obtained by the various investigators admits of several explanations. One is that the media in which the test-organisms were suspended, or to which they have been attached, have been very different. Again, until within a few years, the inhibition of the growth of test-organisms by the exceedingly slight traces of mercuric chlorid which may adhere to infected threads or be transferred to liquid culture media, was undoubtedly mistaken for a germicide action. Further, a considerable variability in regard to the power of resistance of anthrax spores has often been noted.

Influence of Media.—Schill and Fischer[1] subjected fresh tuberculous sputum twenty-four hours to the action of solutions of corrosive sublimate. Mixed in equal proportions with the sputum, it made no difference whether the solution was 1:1,000 or 1:500 of water, the result was invariably the same; a failure to disinfect the sputum. The well-known property possessed by corrosive sublimate of coagulating albuminous matter furnishes these authors with a ready explanation of the non-sterilization of the sputum,—the coagulation of the surface of the sputum, thus preventing the penetration of the disinfecting agent to the interior of the tuberculous matter.

The suitability or unsuitability of corrosive sublimate for certain disinfecting purposes is a question which has been widely discussed. For its elucidation much laborious laboratory work has been done, but the results are so contradictory that doubt must still rest on many points,—whether solutions of corrosive sublimate in all strengths coagulate albumen; in what degree the disinfecting or antiseptic power of the solution is destroyed when the mercuric chlorid is changed into albuminate of mercury; as to the conditions under which albuminate of mercury may remain soluble; as to the best auxiliary agents to use for the purpose of preventing undesirable changes in them, or for the purpose of increasing the efficiency of mercuric solutions; etc.

The work of Behring[2] has shown him that, in disinfecting with corrosive sublimate, the success of the operation depends very much upon the character of the medium in which the infec-

1. Mittheil. aus dem Kais. Gesundh., II., 142. 1884.
2. Bekampfung der Infectionskrankheiten, II., 43. 1894.

tious matter is suspended, whether water, bouillon, or liquids, like blood serum, which contain much albumen. Sporeless anthrax bacilli in water are killed by corrosive sublimate 1 :500,000; in bouillon, by 1 :40,000; in blood serum, not with certainty by 1 :2,000. "When corrosive sublimate," he says, "comes in contact with the living tissues of the body it ceases to be $HgCl_2$, but it does not cease to have a germicidal action. * * * * When corrosive sublimate is precipitated by albuminous matter it does not lose its disinfecting power."

Elsewhere, the same author says:

"If, for the disinfection of blood and the fluids of animal tissues, we use a solution of corrosive sublimate stronger than 1 :4,000, albumen is precipitated and the penetration of the sublimate into the deeper portions of the matter to be disinfected is hindered. In a still greater degree does this difficulty occur when we undertake the disinfection of the firmer organic tissues. Here, in fact, only a superficial disinfection is observed.

"The trouble is not, as was formerly assumed, that an inert albuminate of mercury results from the precipitation of the sublimate, but the uniform penetration of the disinfecting agent is prevented by the precipitation."[1]

Some Recent Precautions.—Geppert,[2] fearing that, in experiments with disinfectants, the trace of the disinfecting agent carried over on silk threads or other test-objects, even after they had been rinsed in sterilized water or alcohol, suffices to inhibit the growth of the bacteria attached to them, devised methods of precipitating or neutralizing the traces of the disinfecting agent.

Though Koch taught that corrosive sublimate 1 :1,000 destroys anthrax spores in one minute, and Fränkel destroyed very resistant spores with sublimate 1 :1,000 in thirty minutes, Geppert found that, after precipitating the corrosive sublimate with ammonium sulphid, anthrax spores are never destroyed in half an hour with a 1 :1,000 solution and very seldom in one hour. Sometimes the action of this solution failed to sterilize the spores in several hours, and once they were not killed in twenty-four hours, as was shown by transference to culture media and by inoculations into animals.

1. Zeit. für Hyg., IX., 400. 1890.
2. Deutsche Med. Woch., XVII., 797. 1891.

In experiments of this kind, Geppert does not recommend threads, but prefers a filtered culture to which he adds a solution of corrosive sublimate 1:500, half and half.

Of the two innovations suggested by Geppert, Behring[1] considers the chemical precipitation of the mercuric chlorid an improvement over past methods, but his second suggestion he believes is no improvement.

In a series of experiments made by Dr. C. T. McClintock,[2] precautions like those suggested by Geppert were observed. The medium in which the bacteria were tested was bouillon. His experiments show that, experimentally at least, the germs withstand the action of sublimate as follows:

1:1,000, Staph. pyogenes aureus, 23 hours.
1:100, Staph. pyogenes aureus, 11 hours.
Saturated sol., Staph. pyogenes aureus, 1 hour.
1:1,000, B. subtilis, 41 hours.
Saturated sol., B. subtilis, 85 minutes.
1:200, Swine Plague, 1 hour.
1:1,000, Typhoid Germs, 1 hour.
1:1,000, Germs in feces, 24 hours.
Saturated sol., Germs in feces, 24 hours.

McClintock is forced to the conclusion that the *germicidal* power of solutions of sublimate has been enormously overestimated. He closes his work with the following summary of results and conclusions:

1. The high rank heretofore given corrosive sublimate as a *germicide* is without warrant and was based upon faulty experiments.

2. The very varying power of resistance in different cultures, as pointed out by Esmarch, and insisted on by Gruber, is an all-important factor to be noted in determining the germicidal value of any agent.

3. Sublimate forms with cellulose, as in cloth, filter paper, etc., with milk, with albuminous bodies, with some part of bacteria, probably the envelop, a chemical compound that cannot be removed by any amount of washing with water. This sublimate when acting on a germ, forms a capsule around it that

1. Ibid., XVII., 893. 1891.
2. Medical News, LXI., 365, 397. 1892.

protects the germ for a time from the further action of the sublimate, and, in turn forms an impenetrable barrier to the growth of the organism, unless removed. This barrier may be removed with salines, and is more rapidly removed in proportion to the renewal of the salines, conditions that are fulfilled in the circulating blood.

While sublimate has no greater germicidal power, it does not follow that it is not a valuable disinfectant. Whether the germs contained in solutions treated with sublimate and disposed of as such material usually is, do or do not grow remains to be proved.

In some recent work with the view to determining the germicidal power of mercuric chlorid, Rorkhoff,[1] of St. Petersburg, sought to have the conditions of his experiments correspond, as nearly as possible, with those found in disinfecting work, particularly in the disinfection of dwellings. His conclusions are that, using the 1:1,000 solution, the most resistant spores are killed in six days; anthrax spores, in nine to ten hours; Staphylococcus pyogenes aureus, in two and one half to five hours; typhoid bacillus, in fifty minutes; diphtheria bacillus, in seventy to eighty minutes; cholera bacillus and anthrax bacteria without spores, in fifteen minutes.

Auxiliaries.—The addition of various chemical agents to solutions of mercuric chlorid has been recommended for the purpose of preventing the precipitation of albuminoids or of increasing the germicidal power of the sublimate solutions. In 1887, Laplace and Behring published the result of their work which indicated that sublimate solutions are much more active when 5 parts per 1,000 of hydrochloric acid or of tartaric acid are added to them. Behring[2] and others have more recently recommended the addition of ammonium chlorid, of potassium chlorid, or of common salt, 5 parts to 1,000 of the sublimate solution. We are told that solutions thus made keep better, that the reducing action of light is lessened, that the coagulation of albumen is avoided, and, as the carbonates and other alkalis then cause no precipitate, the solutions may be made with ordinary water after it has been boiled, instead of with distilled water.

1. Revue D'Hygiene, XIX., 738. 1887.
2. Bekampfung der Infectionskrankheiten, II., 51. 1894.

Lübbert and Schneider[1] claim that, from a chemical as well as from a practical point of view, sodium chlorid is a more suitable addition than tartaric acid or ammonium chlorid. It is better than the former to hold albuminate of mercury in solution, and better than the latter to prevent the precipitation of the mercury when the solutions are made with common well water. The proper quantity of sodium chlorid to acid is 1.3 parts to 1 part of mercuric chlorid.

The addition of sulphuric acid, according to Panfili,[2] increases the germicidal potency of disinfecting solutions more than the addition of either hydrochloric acid or tartaric acid, and he holds that the action of sodium chlorid is inferior to that of the acids.

Garre[3] agrees with Panfili that acids are superior to common salt as an auxiliary, and especially recommends acetic acid, 1-20 per cent.

Pane[4] found that the addition of tartaric acid to a 1:2,000 solution, whether in distilled water or in ordinary water, distinctly increases its efficiency, and renders it equivalent to a 1:1,000 solution with the addition of sodium chlorid. He pronounces the 1:1,000 solution with tartaric acid very efficient.

Beckmann[5] and Vignon[6] add their testimony to that of others that the addition of common salt increases the effectiveness of sublimate solutions. Vignon recommends 10 grams of salt, or 1 ccm. of hydrochloric acid to 1 gram of corrosive sublimate.

In his experiments to determine whether the disinfecting action of the 1:1,000 solution of corrosive sublimate is increased by the addition of acids, or common salt, Panfili[7] used anthrax spores which were not killed in less than from ten to eleven hours by the simple solution. Geppert's precautions were observed. He found that the addition of from 5 to 10 per cent. of sulphuric acid to the sublimate solution increased its disinfectant power very much, and that the addition of hydrochloric or tartaric acid increased the germicide action, but in a lesser degree. Sodium chlorid added to the solution increased its action somewhat, but not so much as the acids.

1. Deutsche Med. Woch., XIV., 828. 1888.
2. Revue D'Hygiene, XVI., 618. 1894.
3. Cor. Bl. f. Sch. Aerzts.—Deutsche Med. Woch., XV., 723. 1889.
4. An. dell' Istituto D'Ig. Sperimentale dell' Univ. di Roma, II., 88. 1890.
5. Centr. für Bak., XX., 17. 1892.
6. Revue D'Hygiene, XVI., 618. 1894.
7. Annali dell' Ist D'Ig. Sperim. della R. Univ. di Roma, III. (N. S.), 529. 1893.

Weyland,[1] however, claims that our most efficient disinfectants, those which are destructive of spores, possess the property of precipitating albumen,—saturated solution of carbolic acid, corrosive sublimate, silver nitrate, and tricresol solutions. He says that the addition of sodium chlorid to comparatively weak solutions of carbolic acid increases the germicidal power of the solutions so that they precipitate albumen and destroy anthrax spores, while, on the other hand, the addition of common salt to solutions of corrosive sublimate prevents their precipitation of albumen and lessens their germicidal power.

The results obtained by Rorkhoff,[2] of St. Petersburg, tend to confirm the observations of the author last quoted, for, in his hands, the disinfecting value of solutions of mercuric chlorid are lessened by the addition of sodium chlorid (1 per cent.), tartaric acid or hydrochloric acid (5:1,000), or carbolic acid (5 per cent.).

Other Solvents, Etc.—Solutions of mercuric chlorid in absolute alcohol, according to Lenti,[3] have no action on anthrax spores; but a 1:1,000 solution of sublimate destroys anthrax spores in twenty-four hours if it contains 2 per cent. of water. In glycerin mercuric chlorid is not effective until 40 per cent. of water has been added.

As is well known, solutions of corrosive sublimate keep better in the dark than when exposed to light. Michaelis[4] made an experimental study to determine the influence of the color of the glass in which the solutions are preserved. His observations show that yellowish-brown glass prevents, better than any other color, the decomposing action of the light.

Disinfection of Excreta.—Some time ago Dr. W. B. Hills[5] characterized the employment of corrosive sublimate for the disinfection of large masses of material, such as the contents of privy vaults, cesspools, etc., as absurd. He reminded us that albuminoids are coagulated, and that the resulting albuminate of mercury is insoluble. If soluble, it would be changed immediately to inert sulphids in masses of fecal matter. Professor

1. Centr. für Bak., XXI., 798, 1897.
2. Revue D'Hygiene, XIX., 738. 1897.
3. Hyg. Rundschau, IV., 235. 1894.
4. Zeit. für Hygiene, IV., 395. 1888.
5. Boston Med. and Surg. Jr., CXIX., 169. 1888.

Vaughan,[1] of Ann Arbor, answered Dr. Hill's criticisms, stating that albuminate of mercury is soluble in solutions containing organic matter, and that it diffuses through them; that fecal matter contains but little albumen,—only 0.52 of 1 part in 1,000. Replying to this, Dr. Hills[2] contends that albuminate of mercury is but very slightly soluble even in the presence of organic mattter, and he quotes authorities and adduces experiments, and reaffirms that the albuminate is decomposed by hydrogen sulphid and by other incompatibles in fecal matter.

Behring[3] also warns us that in putrefying material when sulphur compounds are liberated, mercuric chlorid is changed into inert sulphids.

The Committee on Disinfection[4] of the American Public Health Association of 1885 recommended for the disinfection of liquid fecal discharges, a solution of 1:500 of sublimate with the same quantity of potassium permanganate, the time of exposure to be not less than two hours and the quantity of the material to be disinfected not in excess of that of the solution used.

Among the disinfectants tested by Foote,[5] the simple solution of mercuric chlorid was found to be inefficient, but the solution of this agent with the addition of sodium chlorid was the most efficient disinfectant tested by him.

In the experience of Uffelmann,[6] the simple solution of sublimate 1:500 failed, while 1:500 with hydrochloric acid destroyed with certainty all germs in twenty-four hours.

In an extensive series of tests made by Vincent,[7] he found that sublimate 1:1,000 with hydrochloric acid, when added in equal volume to the matter to be disinfected and mixed intimately, failed to disinfect in four days. He concluded that mercuric chlorid is a very inefficient disinfectant for fecal matter.

Antiseptic Value.—"There is a great difference," says Behring,[8] "between the antiseptic power of mercuric chlorid in albuminous, and in non-albuminous material.

1. Boston Med. and Surg. Jr., CXX., 1. 1889.
2. Ibid., p. 190. 1889.
3. Zeit. für Hygiene, IX., 407. 1890.
4. Disinfection and Disinfectants, p. 47. 1888. Concord.
5. Amer. Jr. of the Med. Sciences, XCVIII., 329. 1889.
6. Berliner Klin. Woch.—Centr. für Bak., XII., 233. 1892.
7. Annales de l'Inst. Past., IX., 11. 1895.
8. Deutsche Med. Woch., XV., 839. 1889.

"It has been demonstrated that albuminous culture media, those in which bacteria are already developing, are capable of converting $HgCl_2$ into calomel, and even of reducing it to metallic mercury, thereby wholly destroying its antiseptic action. When we compare mercuric chlorid with iodoform, we find a remarkable difference in antiseptics. Iodoform of itself is an indifferent body, when brought into wounds, but, when it finds the material for its decomposition, can act as an efficient antiseptic. On the other hand, we bring an aqueous solution of sublimate with its remarkable antiseptic possibilities into wounds and see it become wholly inoperative.

"The antiseptic value of mercuric chlorid is diminished not only by bacteria and their products, and by the albuminous constituents of the blood and secretions from wounds, but it is observed under the influence of the reducing action of light in the presence of organic matter even when the quantity of the organic matter is as small as in water which has not been distilled. Further it is diminished by fibres from bandages and by all strongly reducing chemical substances.

"In practice all of these agents exert more or less influence upon the antiseptic value of sublimate, and, without an exact investigation and a careful consideration of the chemical changes which the sublimate undergoes when used in the treatment of wounds, one cannot correctly estimate its antiseptic value."

Although, under the most favorable conditions, mercuric chlorid 1 : 1,000,000 will, as Koch learned, retard the development of anthrax bacilli, 100 times as much, or 1 : 10,000 is required to inhibit the growth of the same organism in blood serum as Behring points out.

It has been noted by various observers that the Staphylococcus pyogenes aureus is not readily destroyed with mercuric chlorid. In the experiments of McClintock already cited, this microorganism in bouillon was not destroyed in less than twenty-three hours. In the work of Dr. A. C. Abbott,[1] this same bacterium in sterilized distilled water survived exposure to mercuric chlorid, 1 :1,000, twenty minutes, while in bouillon, it was not killed in sixty minutes. When exposed twenty minutes in water

1. Johns Hopkins Hosp. Bul., II., 50. 1891.

about one colony, on an average, developed; when in bouillon the average number of colonies was 1,103. He concludes that:

"To the employment of sublimate solutions upon wound-surfaces it is plain that there are at least two serious objections.

"First, the albumen of the tissues and fluids of the body tend to diminish the strength of, or indeed, render entirely inert, the solution employed.

"And second, the integrity of the tissues is materially injured by the application of solutions of this salt."

On account of the irritating qualities of the acids, Lübbert and Schneider[1] prefer, in surgical work, the addition of common salt to solutions of sublimate, 1.3 grams of salt to 1 gram of corrosive sublimate.

Poisonous Qualities.—Corrosive sublimate is, of course, a dangerous poison, but, unless it is swallowed, there is little danger from its use as a disinfectant. Of the 1:1,000 solution, there is little less than one sixteenth of a grain in one dram of the solution, hardly the equivalent of a maximum therapeutic dose for an adult. In this strength, it may safely be used for washing the hands, beard, hair, and face of the nurse, the attending physician, or the disinfector after leaving infected rooms.

The lethal dose for animals, administered hypodermically, is, according to Behring,[2] from 1-100,000 to 1-80,000 of the weight of the animal. Comparing the 1:1,000 solution of mercuric chlorid with the 5 per cent. solution of carbolic acid, the degree of toxicity of the former is lower than that of the latter. Again, he says[3] the toxicity of sublimate is not greater than that of other metallic salts, taking into consideration their relative antiseptic powers.

Dr. Holt,[4] referring to the introduction of corrosive sublimate as a disinfectant into the New Orleans Quarantine Station, says: "Our declaration at that time is confirmed by an experience of four years' trial on an immense scale, that our standard solution, as used in sanitation, is absolutely harmless to persons unless it is swallowed, it matters not how extensive or constant the contact."

1. Centr. f. Bak., III.,—D. M. Woch., XV., 732. 1889.
2. Bekampfung der Infectionskrankheiten, II., 66. 1894.
3. Zeit. für Hygiene, IX., 407. 1890.
4. Rpt. of Com. of Am. P. H. Assoc., p. 219. 1888.

On the other hand, one of the public health journals[1] reports that some of the disinfecting staff in the city of Paris have suffered symptoms of mercurial poisoning.

Sjoqvist,[2] of Stockholm, examined the urine of seven persons who had lived in houses from a few days to one year after their disinfection with mercuric chlorid. A trace of mercuric chlorid was found in the urine of two persons, both in the same house. Three to four grams per room had been used.

He says that mercuric chlorid volatilizes very slowly in the temperature of an ordinary room, and that it was found in large quantity in wall-papers a year after disinfection.

In German literature, the fear of poisonous results is often noted, but in a discussion before a meeting of the German Public Health Association, Professor Loeffler[3] expressed the opinion that the danger to the inhabitants of rooms after the walls and floors have been disinfected with corrosive sublimate is very slight indeed, or absent.

Solutions and Uses.—The addition of potassium permanganate to solutions of sublimate unfits them for other use than the disinfection of excreta, and their use in that direction is of doubtful value. The American Public Health Association's standard Solution No. 3, containing copper sulphate, has the disadvantage of slightly staining white goods even when reduced to 1:1,000 of sublimate. A large number of samples of cotton, woolen, and silk goods, soaked twenty-four hours in a cold 1:1,000 solution of corrosive sublimate in water, suffered no more from changes in colors than when soaked the same length of time in Kennebec River water.

The quantity of the various chemicals to be added to the 1:1,000 solution of mercuric chlorid is more frequently stated as 5 parts or more of common salt, or 5 parts of hydrochloric acid, or of tartaric acid, to 1,000 parts of the sublimate solution.

The solution used by the Board of Health of the City of New York is: corrosive sublimate (pulverized), 60 grains; common salt, 2 tablespoonfuls; water (hot), 1 gallon. Dissolve. Keep in glass, earthen, or wooden vessels.

1. Jr. of State Medicine, IV., 146. 1896.
2. Hygienische Rundschau, IV., 370. 1894.
3. Deutsche Viert. für öff. Gesund., XXIII., 150. 1891.

Solutions of corrosive sublimate are wholly unsuitable to the disinfection of material containing much albumen, as tuberculous sputum. Their use for the disinfection of excreta, fresh or in bulk, is of very doubtful expediency, as is indicated by the discrepant results obtained by various investigators.

So far as there remains a legitimate sphere for the use of corrosive sublimate, it seems to be restricted to the disinfection of walls and floors, wood finish of furniture, upholstered furniture and clothing which cannot otherwise be disinfected, and the personal disinfection of hands, hair, beard, and face.

Loeffler[1] regrets that corrosive sublimate is not more used for the disinfection of walls and floors. He deems it trustworthy and preferable to carbolic acid because it leaves no odor.

Other Mercurial Salts.—In the experiments of Sternberg,[2] mercury biniodid had a greater antiseptic power than mercuric chlorid. The work of Dr. G. Sims Woodhead[3] indicates that the biniodid has the advantage over the bichlorid in that it does not coagulate albuminous solutions. As an antiseptic, 15½ grains of the biniodid with a slight excess of potassium iodid are to be dissolved in 34 ounces of distilled water. Such a solution is stable, but is not really one of biniodid of mercury, but is a double salt of potash and mercury. Dr. Woodhead's experiments appear to indicate that the biniodid is a more efficient antiseptic than the bichlorid, and that with the former salt there is not so much danger of toxic effects.

In a comparative study of the disinfectant powers of mercury bichlorid and mercury biniodid made by Viquerat,[4] these two agents were tried on B. typhosus, B. anthracis, B. pyog. fœtidus, B. subtilis, B. strumitis, B. pyocyaneus, Staph. citreus, and S. aureus.

The bichlorid 1:1,000 showed greater activity than the customary 1:5,000 solution of the biniodid. Even in the solution of 1:1,000, the biniodid was not so efficient as the bichlorid. For instance, anthrax bacillus could remain in the bichlorid only five minutes without being destroyed, while in biniodid, 1:1,000, it could remain fifteen minutes, and in biniodid, 1:5,000, it could

1. Op. cit., p. 149. 1891.
2. Disinfection and Disinfectants, p. 51. 1888. Concord.
3. The Medical News, LIV., 521. 1889.
4. Centr. für Bak., V., 584. 1889.

survive two hours. The typhoid bacillus lived not longer than five minutes in bichlorid, but in biniodid, 1:1,000, as well as in 1:5,000, as long as a quarter of an hour.

As to the comparative toxicity of the two salts, the author thinks there is no difference.

The experience of Behring[1] teaches him that, disregarding the permanence of the solutions, it makes no difference which mercurial preparation we choose, so long as we are able to bring it into solution, and this applies to albuminate of mercury as well. None of the mercurials, he says, possess higher disinfectant value than corrosive sublimate.

MILK. (See TUBERCULOSIS—*Tuberculous Milk.*)

MOUTH.

The study of the bacteriology of the mouth has developed the fact that a great variety of micro-organisms is habitually to be found there. Among these organisms, pathogenic germs are often found. Thus, in examining the mouths of children treated in hospitals for other diseases than diphtheria, Roux and Yersin found that 33 per cent., or more, of them contained the bacillus of diphtheria in an attenuated form.[2] In 1880, Sternberg[3] discovered the micrococcus of croupous pneumonia in the human saliva, and the investigations of many observers have since confirmed the fact that the germ of pneumonia is a frequent inhabitant of the mouths of well persons. Quite a large number of other pathogenic bacteria are found frequently, or at longer intervals, in the human mouth. Thus, at times, known or unknown, a rational indication for the disinfection of the mouth of a healthy person exists. During infectious diseases, or in the period of convalescence from them, disinfection of the mouth is more frequently needed.

Dr. W. D. Miller, an American dentist long resident in Berlin, has probably done more than any other person in the study of the infectious organisms of the mouth and in testing accurately the suitability of various agents as disinfectant or anti-

1. Bekampfung der Infectionskrankheiten, II., 58. 1894.
2. Revue D'Hygiene, XIV., 97. 1892.
3. Manual of Bacteriology, p. 296. 1892.

septic washes for the mouth. Tests were made with nearly all the available antiseptics.[1] Corrosive sublimate 1:2,000 effected a marked diminution in the number of the germs in one minute. Complete sterilization, however, required, on an average, over five minutes. The efficacy of the sublimate was increased in a surprising degree by the addition of benzoic acid.

Trichlorid of iodin 1:2,000 was decidedly superior to the sublimate. It is, moreover, not at all disagreeable, but its acid reaction unfits it for daily use as a mouth wash. In the strength of 1:2,000, sterilization was effected in one and one fourth minutes; and in the strength of 1:1,500, sterilization was accomplished in forty seconds.

Some of the other antiseptics tested were: benzoic acid 1:300 required two to two and one half minutes; lysol 1:200, five minutes; carbolic acid 1:100, five minutes; boric acid 1:50, eleven minutes; thymol 1:2,000, five and one half minutes; hydrogen peroxid 4:100, six minutes; saturated alcoholic solution of saccharin 1:400, three fourths to one minute; oil of eucalyptus 1:625, eight minutes; oil of cinnamon 1:400, eight minutes; oil of wintergreen 1:350, twelve minutes; oil of peppermint 1:600, eleven minutes; salicylic acid 1:300, three fourths to one minute.

His experiments and his experience indicate that there are very few substances at present in the dental materia medica which are available for disinfecting the human mouth. Mercuric chlorid is much restricted by its exceedingly disagreeable taste and the possibility of toxic effects. Trichlorid of iodin is hampered by its acid reaction which restricts its use to acute infectious diseases of the mouth or throat. Salicylic acid labors under a similar ban.

"We have, accordingly, only saccharin and benzoic acid left from which to construct antiseptic mouth washes *for daily use,* since a substance which requires over five minutes to devitalize bacteria cannot be expected to accomplish much in the short time during which a mouth wash is kept in the mouth. We may make an exception, however, in favor of the peroxid of hydrogen, which, on account of its non-poisonous and non-

1. Tr. Seventh Intern. Cong. of Hygiene, II., 55. 1892.

irritant character, may be used more frequently and kept longer in the mouth than the great majority of other antiseptic liquids."

Dr. Miller further says: "A mouth wash which I recommended years ago and which is decidedly superior to the best of the many so-called antiseptic mouth washes on the market, has the following construction:

R	Acid. benzoic..........................	3,0
	Tinct. Eucalypt........................	15,0
	Alcohol. abs..........................	100,0
	Ol. menth. pip.........................	0,75

"For the last year I have been making experiments with saccharin, which manifests a very remarkable action upon the bacteria of the mouth. It appears also to be one of the least poisonous of the substances recommended for the treatment of the oral cavity, and has no deleterious action upon the teeth.

"I have employed it in the following form:

R	Saccharini	2,5
	Acid. benzoic	3,0
	Tinct. Rhatanae......................	15,0
	Alcohol. abs..........................	100,0
	Ol. menth. pip.......................	0,50
	Ol. cinnam	0,50

"Three ccm. of this to 27 ccm. water kept in the mouth a full minute has a very marked effect upon the number of living bacteria in the mouth. If instead of water we use a 4 per cent. solution of peroxid of hydrogen in connection with the tincture, we obtain a still more striking result." With a wash consisting of benzoic acid and saccharin in peroxid of hydrogen the number of bacteria was reduced by $\frac{14}{15}$ths.

"In conclusion, I may therefore mention as antiseptic mouth washes trichlorid of iodin, 1:2,000 to 1:1,500; bichlorid of mercury, 1:2,000, in conjunction with benzoic acid, 1:300; salicylic acid, 1:300 to 1:250; benzoic acid, 1:300 to 1:250; saccharin, 1:400, preferably in combination with benzoic acid. The trichlorid of iodin and bichlorid of mercury are restricted to occasional use, particularly the trichlorid should be used with care; salicylic acid must likewise be kept under observation; saccharin has a disagreeable taste; only benzoic acid appears to suffer from no pronounced undesirable qualities."

In the municipal laboratory of hygiene of Naples, Dr. Montefusco experimented with solutions of the essence of peppermint and other antiseptics. In his experience, they did not show a marked advantage over rinsing the mouth with sterilized water. Dr. Vallin, who reviews the work of Montefusco, says that cleansing the teeth with a brush and soap morning and evening, followed by prolonged rinsing with a weak solution of carbolic acid and the essential oils, or menthol, fulfils all indications.[1]

Weak solutions of formaldehyde have been recommended as mouth washes. They would, undoubtedly, be efficient disinfectants, but, used too strong, they cause intense smarting of the tongue. A solution of 1/4, or, at the most, 1/2 per cent. of formalin in water is as strong as the average mouth will bear. Behring, finding that chloroform, in quite weak solutions, is rapidly antiseptic in its action, recommends chloroform water as a mouth wash.

MUD, OOZE, SLUDGE.

The disinfection of material of this kind could be done with the hypochlorites,—chlorid of lime or hypochlorite of soda prepared by the electric current where that is available.

Rabot's process has some repute in Europe. It consists in the use of 500 grams of sulphate of iron followed by 1 kilogram of caustic lime to each cubic metre of material to be treated.

NITRATE OF SILVER. (See SILVER and SILVER SALTS.)

OZONE.

Whether ozone in nature has any important influence in restraining or favoring the action of infectious agents, is still an unsettled question. In the quantities which may now be evolved by artificial means, it may act as an irritant poison to animal life, or rapidly destroy bacteria and all other low forms of plant growth, particularly in the presence of moisture.

The results of some experiments which are available indicate that ozone has at least a slight destructive influence upon dry bacteria as they are found in the air of rooms. Dr. Mills[2]

1. Revue D'Hygiene, XIX., 447. 1897.
2. La Clinique, X., 617. 1896.

studied the germicide action of ozone artificially liberated in a medical ward of a hospital. The electric ozone generators were allowed to deliver ozonized air into the room, two hours each day, or every other day. The best results were attained when ozone was admitted every day. When ozonized every day, the total number of colonies in each Petri dish exposed to the air averaged 118, when not ozonized, 182. The number of colonies of Bacterium coli commune, when the room was ozonized, was five; when not ozonized, nine.

Dr. Kowalkowsky[1] gives a resumé of some recent work which has been done in Russia. Dr. Krukowitsch, testing the action of ozone on the bacteria of putrefaction, found that the fresh, or moist bacteria, were much more easily killed than were dried bacteria. In a large flask 3 milligrams of ozone to the cubic metre sufficed to destroy fresh bacteria, but 8 milligrams were required to devitalize the dry bacteria. In a room of 25 cubic metres, 30 milligrams per cubic metre failed to destroy even the moistened germs.

In the experience of Lukaschewitsch, even the large quantity of 1.5 grams per cubic metre was found insufficient to destroy anthrax spores or the bacteria of decomposition when dry, but, when damp, the latter bacteria were killed with one fifth that proportion of ozone. This last experimenter believes that the explanation of the ease with which Krukowitsch destroyed his bacteria is that nitrogen dioxid is liberated with the ozone in the process which was used.

In the Pasteur Institute, Paris, Christmas[2] investigated the antiseptic action of ozone. From 1.5 to 2 milligrams of ozone per litre of air sufficed to prevent the development of sporeless anthrax bacilli, typhoid bacillus, diphtheria bacillus, and Aspergillus niger. In forty-eight hours growing cultures were strongly acted upon, and in ninety-six hours they were dead. Air which contained 0.5 milligram of ozone in each litre was almost irrespirable, but had no effect whatever on bacteria; fruit and meat decomposed as rapidly as in ordinary air. As an antiseptic for inhabited rooms, its use is, he finds, entirely imprac-

1. Zeit. für Hygiene, IX., 89. 1890.
2. Annales de l'Inst. Past. 1898.—Centr. für Bak., XV., 1016. 1894.

ticable, on account of the irrespirability of air which contains quantities below that which has any antiseptic action.

Purification of Water.—In the disinfection and purification of water, late experimental work and the improvement in apparatus for the generation of ozone promise much. At the meeting of the Electro-technic Society of Berlin, in 1891, Dr. Frölich[1] reported the progress which had been made by the firm of Siemens & Halske in devising electric apparatus for the production of ozone, and in the technical application of ozone. Then, referring to the action of ozone on animals and plants, he stated that, in man, the breathing of air in which the generation of ozone has proceeded far, becomes unpleasant or injurious, and coughing results. Hospital wards containing patients cannot, therefore, be ozonized. Insects are destroyed with ozone in twenty or thirty minutes. All water-bacteria are destroyed, as well as all algae growing in water. This necessarily forbids the ozonization of water to be subjected to sand-filtration when the efficiency of the filtration depends upon the superficial layer of algae.

The experiments in sterilizing water with ozone were always successful. Though pathogenic bacteria were not added, the fact that all of the water-bacteria were devitalized, indicated the destruction of pathogenic bacteria if they had been present. The ozonization of water destroys various offensive or harmful contents. Hydrogen sulphid is destroyed, ammonia is oxidized and transformed into nitrites and nitrates, iron is precipitated as hydroxid, and the bacteria of decomposition are destroyed. There were, he believed, good grounds for assuming that bad water may be converted into potable water by the ozone treatment.

Oppermann[2] studied the results of electrolyzing water, using spiral platinum electrodes. He found that ozone was the potent factor in the purification or sterilization. There was the most abundant production of ozone when the water was kept at a low temperature,—5°-6° C. Under the most favorable conditions, from 3 to 6 per cent. of ozone was produced. Changes in the water were: oxidation of the organic and organized contents,

1. Gesundheits-Ingenieur, XIV., 543. 1891.
2. Weyl's Handbuch der Hygiene, I., 718. 1896.

and eventually of the ammonia and nitrites. Chlorin was liberated when the water contained chlorids and hydrogen peroxid in so slight quantities that its influence may be disregarded. The more polluted the water the larger the quantity of ozone required.

He found, further, that the electrolyzed water is free from germs, but its ozonized taste is unpleasant and its use for drinking purposes causes derangement of the stomach and vomiting. To render the electrolyzed water suitable for drinking, Oppermann submitted it to a secondary electrolytic action, using aluminum electrodes. This resulted in the formation of aluminum oxid and the precipitation of this as aluminum hydroxid clarified the water and removed the ozone. The resulting water was free from germs, clear, pleasant to the taste, and possessed no undesirable qualities.

The action of the ozonization was complete even when large quantities of typhoid and cholera bacilli had been added to the water.

At the request of the Imperial Board of Health of Germany, Ohlmüller[1] made a detailed study of the disinfective power of ozone. His investigations showed that ozone has but little action upon dry bacteria, but that, suspended in water, they are strongly acted upon. Distilled, sterilized water to which 3,717,000 anthrax spores per cubic centimetre of water had been added was sterilized in ten minutes with 89.9 milligrams of ozone. With 58 milligrams of ozone, 57,000 anthrax bacilli were destroyed in ten minutes; 12,247,000 typhoid bacilli with 19.5 milligrams of ozone in two minutes; and 2,791,000 cholera bacilli with 16.7-19.5 milligrams of ozone in two minutes.

Treating sewage, water from the Spree, and other polluted waters, he found that they were less easily sterilized than distilled water. The water from the Spree was sterilized in ten minutes with 83.6 milligrams of ozone, but sewage was not sterilized in an hour with 156.3 milligrams.

Ohlmüller believes that his experiments show conclusively that, when water is not too grossly polluted, ozone exerts a destructive action upon the bacteria. He deems it likely that

1. Arbeiten a. d. Kais. Ges., VIII., 229. 1892.

ozone can be utilized for the purification and sterilization of river waters for drinking purposes.

His investigations indicating the practicability of sterilizing water with ozone paved the way for its application on a large scale to the treatment of water supplies with the same agent. It appears that this was first* accomplished in Oudshoorn near Leyden, Holland.

The sterilization of water in this place by means of ozone appears, according to Professor Ermengem,[1] of Belgium, to have been a perfect success. Cold, dry air is subjected to the action of an alternating electric current of great intensity. This ozonized air is then driven under pressure into the sterilizers where it comes in contact with the water to be sterilized. The source of the water supply is the Old Rhine. This ancient outlet of the Rhine with its many locks is converted practically into a canal. It receives the polluting matter from a populous country and many towns, the refuse from factories, and it is traversed by numerous boats. The water is of a dark brown color. It has an abundance of suspended organic and inorganic matter, and it has a repugnant odor. Chemically and bacteriologically, it is a very bad water.

Before this water is submitted to the action of ozone, it undergoes a preliminary filtration through sand. This filtration removes the suspended matter, the larger part of the bacteria, but the chemical character of the water is but slightly improved, and its offensive taste and smell continue. The number of bacteria in the unfiltered water varies from 5,000 to 100,000 per cubic centimetre; the filtered water contains from a few hundred to a few thousand bacteria.

The result of the ozonization of this filtered water is to destroy all of the aquatic species of bacteria and all the most resistant of the pathogenic bacteria that may find their way into the water. This sterilization is a constant and regular result of the prolonged action of the process. The ozonized water loses all its disagreeable taste and smell, there is a considerable diminution in the soluble organic matter, and no harmful or undesirable changes result. We are told that the improvement in the character of the water is extremely satisfactory from every point of view.

1. Annales de l'Inst. Past., IX., 673. 1895.

PARAFORM. (See FORMALDEHYDE—*Available Sources.*)

PEAT.

Dried pulverized peat (*Torfmull*) has been used considerably as an absorbent and deodorant in dry conservancy systems. As being lighter and more absorbent, it may conveniently take the place of dry earth in earth-closets. As stated by Von Esmarch,[1] from 25 to 40 kilograms (60 to 88 lbs.) per head yearly are required, costing in Germany, from 31 to 50 cents, American money.

Fränkel and Klipstein[2] carried out an extended series of experiments for the purpose of determining the germicidal action of pulverized peat, or peat meal. Their experiments indicate that, when bouillon cultures are mixed with the powdered peat so that the mixture remains damp, the cholera bacillus is destroyed in two hours and a half. Under natural conditions, when cholera bacilli are mixed with urine, as well as peat meal, the experiments indicated that the destruction of the bacilli is not accomplished in less than eight or nine days. In some of the experiments under these conditions, the vitality of the bacillus was prolonged for fourteen days.

These experimenters sought to determine whether the addition of some of the chemical agents, which would not injure the mixture for agricultural purposes, might not hasten the germicide action of the peat. Kainite had no beneficial influence in this direction. On the other hand, the addition of superphosphate (*Superphosphatgyps*) increased the germicide action of the pulverized peat. These authors conclude that the opinion that pulverized peat has a conserving influence upon infectious matter is incorrect; on the other hand, their experiments indicate to them that the peat itself has a considerable power of disinfection which may be greatly increased by the addition of superphosphate. The composition of the superphosphate used by them is given as: total phospheric acid, 15.35 per cent.; phospheric acid soluble in water, 12.06 per cent.; phospheric acid soluble in alcohol, 8.51 per cent.; gypsum ($Ca\ SO_4+2H_2\ O$), 56.58 per cent.

1. Hygienesches Taschenbuch, p. 212. 1896.
2. Zeit. für Hygiene, XV., 333. 1893.

The question of the value of pulverized peat as a disinfectant for excreta was also studied by Gärtner,[1] of Jena. His conclusions are essentially those of Fränkel and Klipstein,—that pulverized peat alone has little disinfectant power, but that it acts quite efficiently, though somewhat slowly, in destroying cholera and typhoid germs when it contains 20 per cent. of superphosphate or 2 per cent. of sulphuric acid. An intimate mixture of the disinfecting material and the excreta is essential to certainty of results.

Loeffler and Abel[2] found that the disinfecting influence of pulverized peat itself upon cholera bacilli is very slight, but that its action in this direction is decidedly increased by the addition of equal quantity, by weight, of superphosphate or 2 per cent. of sulphuric acid. When mixed with 50 per cent. of superphosphate containing 2 per cent. of sulphuric acid, all of the cholera germs were destroyed in two hours.

Further experiments showed that the typhoid bacillus in excreta required four days for its destruction with pulverized peat containing 2 per cent. sulphuric acid, and in some cases twelve days were required. This method of treating infected excreta is, therefore, applicable only when the matter may remain undisturbed for some weeks before it is removed.

The results obtained by Vogel[3] indicate that peat cannot destroy the germs of infectious disease. The origin of the peat makes no difference. The destruction of these germs can be accomplished with peat to which 2 per cent. sulphuric acid, or 10 per cent. phosphoric acid has been added.

The experiments of Riecke[4] show that the disinfecting properties of pulverized peat are very much increased by the addition of ferric sulphate. Typhoid and cholera germs are destroyed in two minutes when mixed with 2 parts by weight of peat meal and 1 part of ferric sulphate. He found that ferric sulphate is a much better addition to pulverized peat than acid.

1. Zeit. für Hygiene, XVIII., 263. 1894.
2. Centr. für Bak., XVI., 30. 1894.
3. Deutsche Viert. für öff. Ges. (Supplement), XXVII., 218. 1897.
4. Zeit. für Hygiene, XXIV., 303. 1897.

PERMANGANATES.

Potassium Permanganate.—In Sternberg's[1] experiments 0.12 per cent. destroyed the micrococcus of pus in culture solutions, but 2 per cent. were required to destroy the virulence of septicemic blood. Applied to a culture of anthrax bacilli, 1:250 prevented development. A solution of the same strength acting four hours delayed the development of anthrax spores in the culture fluid, but did not destroy them; but they were destroyed in four days.

In Koch's[2] experiments a 1 per cent. solution did not kill anthrax spores in two days, but a 5 per cent. solution did within one day. Among the disadvantages enumerated by Rideal[3] are that this agent must first expend itself in oxidizing sulphuretted hydrogen, nitrites, ferrous salts, and most organic matters before attacking bacteria. Furthermore, not being volatile, it can only act locally.

A solution of two drams of corrosive sublimate and the same quantity of potassium permanganate to one gallon of water was recommended by the committee of the American Public Health Association for the disinfection of excreta, but the quantity of the solution suggested as requisite for the disinfection and deodorization of a normal evacuation,—one gallon,[4]— is hardly practicable, to say the least.

Calcium Permanganate.—In a communication to the Academy of Medicine of Paris, Bardas and Girard[5] state that permanganate of lime has a very destructive action upon micro-organisms in water. Its action is much superior to that of mercuric chlorid, and it, moreover, is neither caustic nor poisonous. The bacteria on which they tested its disinfective powers are B. coli commune, S. pyogenes aureus, streptococcus of erysipelas, bacillus of typhoid fever, anthrax bacillus, cholera bacillus, and others. A litre of water containing B. coli commune, 80,000 colonies per cubic centimetre, is sterilized in half a minute after the addition of 5 cubic centimetres of a solution of 2 grams of

1. Tr. Am. Public Health Assoc., XI., 204. 1886.
2. Mittheil. aus dem Kais. Ges., I., 264. 1881.
3. Disinfection and Disinfectants, p. 124. 1895. London.
4. Op. cit., p. 272. 1886.
5. Journal de Med. de Paris, VII., 522. 1895.

permanganate of lime to the litre,—sterilized with 10 millegrams of permanganate to the litre of culture.

All of the other bacteria were destroyed with 10 millegrams of permanganate to the litre of culture or suspension in water, but some required its action five minutes. "To obtain immediate and absolute destruction of the most resistant germs, it suffices to add 20 millegrams of permanganate of lime to the litre of water."

PHENOL-ALCOHOLS.

When formaldehyde acts upon the phenols, a series of substances are formed, whose therapeutic peculiarities are of interest. Dr. Georg Cohn,[1] of Berlin, studied two of these, one of which is the reaction product of formaldehyde with phenol, and the other with eugenol. The first, saligenin, was tested upon the cholera spirillum, Staphylococcus pyogenes aureus, and a short bacterium obtained from water. The growth of the cholera spirillum was prevented by 1:500, and that of the Staphylococcus by 1:50. Testing the germicidal action of saligenin, it was found that the cholera spirillum was destroyed in three hours with 1:150, and Staphylococcus, in twenty-four hours with 1:50.

The second agent tested by Cohn is eugenol formaldehyde or eugenoform. It forms a soda salt in long, white, needle-like crystals, which are readily soluble in water. It has a slightly bitter taste, but, unlike eugenol, the sodium salt is not caustic. Eugenoform, 1:500, inhibits the growth of cholera, and 1:200 that of pyogenes. In the proportion of 1:500, it sterilizes cholera in three hours, and 1:50, pyogenes in twenty-four hours. Bouillon cultures were used in the experiments, and after twenty-four hours in an incubating oven, fresh bouillon was inoculated from them.

Both saligenin and eugenoform act upon the bacillus of diphtheria almost as rapidly as upon the cholera spirillum. Eugenoform exceeds saligenin somewhat in its antiseptic action. Eugenoform, even in large doses, is said to be harmless. Cohn refers to the fact that the anti-diphtheritic serum only neutralizes the toxins formed by the diphtheria bacillus, and that therapeutic

1. Zeit. für Hygiene, XXVI., 377. 1897.

agents which have a marked antiseptic action when applied locally to the bacillus in the throat are much to be desired. He suggests these agents for this purpose.

PHENOSALYL.

A mixture which Christmas[1] calls "Phenosalyl" has been tested and recommended by him as a desirable antiseptic. Its composition is: carbolic acid, 9 grams; salicylic acid, 1 gram; lactic acid, 2 grams; menthol, 0.10 centigram. Mix the three acids and warm until liquefaction is complete. This preparation is soluble in water to 4 per cent.

The following shows the comparative quantity of various disinfectants required to destroy Staphylococcus pyogenes aureus in one minute.

Sublimate	2.5
Phenosalyl	7.5
Solveol	15.
Lysol	15.
Creolin	17.5
Carbolic Acid	25.

The degree of resistance of various bacteria to Phenosalyl is as follows, the figures indicating how much of the agent is required to kill each: sporeless anthrax bacillus, 3; pneumonia, 4; bacillus pyocyaneus, 4; tuberculosis, 4; typhoid fever, 5; diphtheria, 5; Staphylococcus pyogenes aureus, 7.

Phenosalyl, as Rideal[2] describes this preparation, is a mixture of phenol, salicylic, benzoic, and lactic acids, made by heating them together at 140° C., adding menthol and eucalyptol, and, after cooling, adding four times the volume of glycerin. It is a clear, syrupy liquid, of sweetish taste. It is easily miscible with water or alcohol, is not poisonous, and has a pleasant and non-persistent odor, which does not cling about the hands and clothes. The solutions have no corrosive action on the skin, the mucous surfaces remain smooth and slippery, and do not become dried up, as is the case after washing with carbolic acid or corrosive sublimate. Of course, this latter advantage belongs

1. Annales de l'Inst. Past., VI., 380. 1892.
2. Disinfection and Disinfectants, p. 200. 1895. London.

to the glycerin, and would equally pertain to phenol or mercuric chlorid in the same medium.

Prof. Fränkel,[1] in a series of bacteriological trials, found that phenosalyl possessed an antiseptic power superior to phenol in dealing with the micro-organisms of cholera, anthrax, pneumonia, typus, diphtheria, tuberculosis, Bacillus pyocyaneus, and Staphylococcus pyogenes aureus. "It is well known that the last-mentioned bacterium is one of the most resistant, but even a 1 per cent. solution of phenosalyl is sufficient to kill it, while to produce the same effect with carbolic acid one must use a 2½ per cent. strength, and the exposure or contact must be continued for a longer period." Phenosalyl has been used by Duloroy in the sterilization of instruments, of gauze, and of different organic substances like blood, as well as decomposing urine and the saliva of consumptives, with most encouraging results. It does not corrode nor discolor metals under ordinary circumstances of contact.

This is an example of a mixture which seems to present great advantages. Of late years there has been a tendency to use complicated compounds, most of them only soluble in alcohol, which, apart from expense and other faults, is inadmissible as a medium for many purposes. It should be noticed that, while in mixtures the properties of the ingredients are mostly retained, in many of these compounds not only are the properties lost, but frequently new and objectionable ones are developed. For example, the desire to avoid the unpleasant odor of iodoform has led to the introduction of many "substitutes" which are costly, unstable, uncertain, and even dangerous in their action.

However, phenosalyl may be reckoned as a convenient preparation of the above aromatic acids dissolved in lactic acid and glycerin, and scented with menthol and eucalyptus. The name is rather an unfortunate one, as leading to a wrong idea of its composition.

PLAGUE.

The preliminary investigations of Kitasato and Yersin indicated that the bacillus of plague is quite easily destroyed by physical and chemical agencies. Kitasato[2] found that bouillon

1. Bacterienkunde, Berlin, 1890. (Quoted by Rideal.)
2. Lancet, II., 1894., 428.

cultures heated to 80° C. in a water-bath were sterilized. They were also destroyed in a few minutes by steam of 100° C. One per cent. of carbolic acid sterilized a culture in one hour, and ½ per cent. in two hours. The bacillus was also destroyed by 1 per cent. of quicklime. Sunlight also rapidly devitalized the bacillus.

In an important paper by Giaxa and Gosio,[1] the results of their experiments are given in the investigation of the action of physical and chemical agents upon the bacillus of plague. Briefly summarized, they are as follows:

Desiccation attenuates the virulence of the bacillus but little; respiration of dust containing it is dangerous.

Pus and blood dried on bandages and kept in the shade thirty days at a temperature of 10° and 18° C. remained virulent. At the temperature 36,° 37,° they were not fully sterilized under five days.

Direct sunshine requires from two to three and one half hours to sterilize, and then only the superficial layers of the culture are destroyed. Protected with a layer of linen or cotton, it requires from six to eighteen hours.

At the temperature of 80° C., the bacillus being humid, it was destroyed in ten minutes; when dry on linen, the germs were not destroyed in forty minutes. At 100° moist cultures were destroyed in five minutes, but it did not suffice for the sterilization of the dry bacillus.

Formaldehyde disinfects only the surfaces. Calcium hydrate, 1 per cent., destroyed in one hour. A solution of potash equal to 5 per cent. caustic potash killed in twenty minutes, the temperature being 60°. Green soap, 5 per cent, at 15° did not kill in twenty-three hours; 3 per cent. at 35° sterilized. Hydrochloric acid, 0.5 per cent., did not sterilize in three hours, but did in six hours. The same acid, 1 per cent., sterilized in three hours.

Carbolic acid, 1 per cent., was efficient in three hours, and so was sublimate, 0.5 per cent., in five hours, and 1 per cent. in two hours.

A still later study of the action of disinfectants upon the bacillus is that of Kasanski.[2] On silken threads, exposed to air and

1. Annali d'Igiene Sperim., VII., 261. 1896.
2. Centr. für Bak., XXIII., 25. 1898.

light, the bacillus retained its vitality from five to fifteen days, but cultures kept at a temperature of 58° C. in the water-bath were destroyed with certainty within one hour. In water from the public supply, it remained alive for from ten to forty-eight days; on sterilized potatoes, sixty-two days.

Dried upon silken threads, the bacillus was destroyed in from one to two minutes by from 1:3,000 to 1:1,000 of sublimate; by 1:2,000 of hydrochloric acid; by 2½ and 5 per cent. carbolic acid; by 5 and 10 per cent. formalin; and by 5 and 10 per cent. acetic acid. Potassium permanganate, lime water, and green soap were uncertain in their action.

POTASH. (See ALKALIS.)

PRIVIES. (See EXCRETA.)

PYOCTANIN. (See ANILIN DYES.)

RESORCIN.

After alluding to the experiments of Andeer, Callias, Dujardin-Beaumetz, Lichtheim, and others, Rideal[1] says that, "it is evident that 1 per cent. of this substance is efficiently antiseptic towards most micro-organisms." Pane,[2] however, subjected Staphylococcus pyogenes aureus on threads to the action of a 1 per cent. solution of resorcin at 37° and they developed entirely normally. Thus he states that the advantages of resorcin in practice do not correspond with the results of laboratory experiments.

ROOMS.

Martin,[3] of Paris, describes the methods of disinfecting rooms in Paris. There are four disinfecting stations in the city. These stations receive for disinfection mattresses, clothing, carpets of small size, skins, furs, etc. The things disinfected with steam are bedding, cotton and linen clothing, and fabrics gener-

1. Disinfection and Disinfectants, p. 171. 1895. London.
2. An. dell' Istituto D'Ig. Sperim. dell' Univ. di Roma., II., 80. 1890.
3. Annales de Micrographie, VIII., 285. 1896.

ally. Those that are disinfected by washing or by spraying are skins, shoes and other leathern work, rubbers and rubber goods, as suspenders, caps, hats, trunks, furs, and wooden articles put together with glue.

When a disinfecting carriage or van is sent to a house that needs disinfection, it is accompanied by three persons, a driver and two disinfectors. The van contains one or more spray apparatus, 12-litre flasks containing a 1:500 solution of mercuric chlorid; several 15-litre jugs and packets containing 750 grams of copper sulphate; a can of cresol, cloths and sponges; cloth bags containing the working clothes of the disinfectors, and other articles to complete the working kit.

Arriving at their destination, the two disinfectors remove their uniforms and put on their working clothes. After entering the room to be disinfected, the disinfectors spray the place which is to receive their kit, bags, blankets, other clothing, etc. They carefully pack and place in the carriage, hermetically closed, the things that are to be removed to the disinfecting station for treatment.

The sprayer is then filled, and ceilings, walls, wainscotings, large carpets left in the house, furniture, and particularly the bed, interior of commode, and all other things that are left in the room are thoroughly sprayed. Nothing is neglected.

Mirrows and their frames, and pictures and other works of art are wiped with a cloth dampened with a disinfecting solution, or sprayed. The tacks are removed from the carpets and the carpets are sprayed plentifully on both sides. The rooms are usually sprayed twice with some minutes intervening, the disinfectors always beginning at the top of the walls and proceeding downward.

The vessels used by the sick person, water-closets, night cabinets, and toilet-tables are carefully washed in a solution of sulphate of copper. Disinfection with sulphate of copper is done after all intestinal diseases, and after diphtheria, croup, and angina where cloths, etc., have been thrown, and after brochial and pulmonary affections where the expectorations have been deposited. For large areas, as of cement or asphalted surfaces in cellars, stables, etc., a 5 per cent. cresol solution is used.

After finishing their room, the disinfectors spray each other, descend from the house with their things, remove their working

suits, put them in the bag which they have for that purpose, and with the van and driver return to their disinfecting station. At the station they carefully disinfect themselves. The sprayers are emptied and washed out each evening.

During the course of infectious diseases, and before the time for the final disinfection, the disinfectors are often called to disinfect other rooms than the sick-room. They do not then enter the sick-room. They remove infected clothing, and, after disinfection, it is returned to the house.

In Berlin the kit which is carried to the houses by the disinfectors contains the numerous articles which they require in their work. As described by Merke,[1] the method of disinfecting rooms may be summarized as follows:

All furniture, pictures, etc., are placed in the middle of the room, the walls are rubbed with bread, unpapered walls with a 5 per cent. solution of carbolic acid, or are whitewashed; the raising of dust is carefully avoided. Polished furniture is rubbed with a cloth dampened in a 2 per cent. carbolic acid solution, and then with a dry cloth; the unfinished backs of pieces of furniture, and the upholstered parts are washed twice with a 5 per cent. carbolic acid solution; wainscoting, doors, etc., are washed with a 2 per cent. solution; pictures not covered with glass are rubbed with a dry, soft cloth; pictures covered with glass, with a cloth dampened in a 2 per cent. carbolic acid solution; toys of little value are burned; toys of more value, leathern articles, metallic articles, glass, etc., are all washed carefully, or rubbed in a 2 per cent. carbolic acid solution. (See Walls, Floors, Furniture, and Bedding.)

SALICYLIC ACID.

Salicylic acid is, as determined by Behring,[2] nearly twice as potent a germicide as carbolic acid. Peroncito observed that anthrax bacilli were destroyed in from ten to fifteen minutes with a saturated aqueous solution.

In the investigations of Schill and Fischer,[3] a saturated aqueous solution, mixed with tuberculous sputum in equal parts,

1. Deutscne Viert. für öff. Ges. XXIII., 263. 1891.
2. Zeit. für Hygiene, IX., 423. 1890.
3. Mittheil. a. d. Kais. Ges. II., 136. 1884.

destroyed the bacilli in twenty hours, thus acting more rapidly than did a 5 per cent. solution of carbolic acid which required twenty-four hours.

Pane[1] also used aqueous solutions of salicylic acid. A 1 : 1,000 solution at 39° destroyed Staphylococcus pyogenes aureus on threads in seven minutes; at 15° in thirty minutes.

A solution of 1 :2,000, not irritating to delicate mucous surfaces, had a distinct antiseptic action. At 37° it killed Staphylococcus pyogenes aureus on threads in twenty to thirty minutes.

Typhoid and diphtheria at 37° were killed in from five to seven minutes with 1 :1,000.

Although salicylic acid acts so energetically upon sporeless bacteria on threads, it is less effective when tested after Esmarch's method. To kill Staphylococcus pyogenes aureus at 37° in from five to twenty minutes, a 3 :1,000 solution must be used in the proportion of two parts of the solution and one of the bouillon.

SALUBROL.

As defined by Dr. Silber,[2] of Breslau, salubrol is a combination of bromin with methylenbisantipyrin. It is an entirely odorless powder. His experiments indicate that it is not poisonous. Applied to bacteria, he finds it an efficient antiseptic and that it has distinct disinfectant qualities. It not only prevents the growth of bacteria, but destroys them. In surgical practice he has found it to be an efficient antiseptic. Its only drawbacks are that, with some patients, when the powder is strewn upon fresh wounds, it produces a mild burning sensation. Some patients, however, do not complain of this smarting. It is absent when a 20 per cent. gauze is used.

SAPROL.

Saprol is a dark-colored, oily preparation with a smell like lysol or creolin. It is said to contain about 26 per cent. of phenol and cresol. It is recommended especially as a disinfectant and deodorant of privy vaults.

1. Annali dell' Ist. D'Ig. Sperim. dell' Univ. di Roma, II., 79. 1890.
2. Deutsche Med. Woch., XXII., 843. 1896.

The value of saprol as a disinfectant for human excreta has been investigated by Laser.[1] It being lighter than water floats upon the surface of fluids which, from the supernatant layer dissolve phenol, cresol, and other coal-tar products which are soluble in water. The stratum of oil diffused uniformly upon the surface meanwhile prevents the rise of ill-smelling gases and, at the same time, prevents the deposit of germs from the air. The presence of ammonia in the fluids covered by saprol increases the solubility of the products of the coal-tar distillation. This is, in brief, Laser's statement of some of the favorable points in the use of saprol. Urine covered with a slight layer of saprol remained clear, without smell, and sterile for twenty-two days. One cc. of saprol sufficed to sterilize in six days 180 grams of a mixture of feces and urine, and 0.5 cc. of saprol sterilized 40 grams of cholera feces in twenty-four hours, and the same quantity of typhoid stools in forty-eight hours.

Laser estimates that 1 per cent. of saprol suffices for the disinfection of feces and urine, and since 150 grams of feces and 1,200 cc. of urine are reckoned daily for each person, 400 grams of saprol per month would be required to disinfect the excreta of one person. The price of saprol, as stated by Laser, is 60 pfennige (15 cents) per litre, or, in larger quantities, 40 pfennige per litre. It would cost, therefore, about 20 pfennige (5 cents) per person per month.

Scheurlen[2] found that the water below the layer of saprol was converted, in a short time, into about 0.5 per cent. of cresol solution. The deodorizing action of saprol is rapid and certain. According to the statements of the manufacturers, and his own analyses, he found saprol to consist of 20 per cent. of mineral oil and 80 per cent. of a 50 to 60 per cent. crude carbolic acid.

Some persons had expressed fear of the danger of using saprol on account of its inflammability. Scheurlen tested this question. He found that the 50 to 60 per cent. crude carbolic acid, from which it is manufactured, flashes at 84° and burns at 93° C., while the mineral oil, which is a constituent of it, has a flashing point of 150° and burns at 171°. Saprol itself flashes at 90° and burns at 102° C.

His conclusions confirm the statements of the manufacturers that saprol is a solution in round numbers of 20 per cent. min-

1. Centr. für Bak., XII., 234-240. 1892.
2. Archiv für Hygiene, XVIII., 35. 1893.

eral oil and 80 per cent. of a 50 to 60 per cent. carbolic acid. Its specific gravity is 0.98-0.99. It therefore floats upon the surface of watery fluids and spreads itself quite uniformly over their surfaces.

Almost immediately after saprol is poured upon the surfaces of fluids, the solution of cresol begins.

Even in twenty-four hours, when the quantity of saprol suffices, the underlying stratum of water is changed into a 0.34 per cent. cresol solution, and in four days, into a 0.43 to a 0.49 per cent.

Saprol is an excellent deodorant, perhaps the best which we possess.

Prodigiosus, cholera, and typhoid bacilli, and the vegetative forms of the bacteria of water and fecal matter are destroyed in from six to twenty-four hours. Spores (anthrax, megatherium) are not killed.

The required quantity of saprol is 1 :80. Watery solutions of cresol is made with very nearly equal facility, whether 100 per cent. crude carbolic acid or 50 to 60 per cent. carbolic acid is used. Formerly 100 per cent. crude carbolic acid was used by the manufacturers, but the lower grade is now employed.

Keiler[1] states that at least 1 per cent. of saprol is needed for the deodorization of vaults.

His experiments show that 5 per cent. of saprol suffices to destroy typhoid fever bacilli in a few minutes, while one half that quantity destroys cholera bacilli in five minutes. He thinks, however, that there is no advantage in the oily constituent and the gradual absorption of the cresol, but that a soap solution of the disinfecting constituents of the crude carbolic acid would be preferable.

Pfuhl,[2] of Hanover, carried out a series of experiments for the purpose of determining the disinfectant action of saprol. He found that a small quantity of saprol added to putrefying urine removed the odor entirely within a few days. The number of bacteria gradually diminished, and in three or four weeks disappeared entirely. Its action was also very marked when it was added to the pus due to urinous infiltration of tissues. Its

1. Archiv für Hygiene, XVIII., 57. 1893.
2. Zeit. für Hygiene, XV., 192. 1893.

action upon solid and semi-solid excreta when the more elevated portions of the matter were uncovered was unsatisfactory.

From 30 to 50 cubic centimetres of tuberculous sputum containing an abundance of resistant bacteria were mixed with one cubic centimetre of saprol and left forty-eight hours at ordinary room temperature. At the end of that time, the sputum was distinctly liquefied. A rabbit which received one cubic centimetre in the peritoneal cavity died of tuberculosis. Staphylococcus aureus in bouillon covered with a layer of saprol was entirely disinfected in twenty-four hours.

Pfuhl made some experiments to determine the degree of inflammability of saprol which indicate that it is not great, but that vaults containing paper, straw, or similar inflammable material into which lighted matches might be thrown might communicate the flames to the saprol.

Pfuhl's conclusions are as follows:

Saprol has a strong antiseptic action, and, in the proportion of 1 to 100, is capable of sterilizing putrefying liquids. Excreta in a solid or semi-solid condition are not efficiently disinfected with saprol. Saprol is an excellent deodorant.

For the disinfection of excreta, 300 to 500 grams of saprol per person per month suffice, but as the deeper portions of solid matter are not sufficiently penetrated by the saprol, mixing by mechanical process is required.

For the complete disinfection of privy vaults, saprol is not suitable and possesses no greater value than the agents which have hitherto been in use.

There is no special danger of inflammability, although in practice the danger is somewhat great on account of the possible presence of other inflammable material.

His experiments indicate that saprol has a more energetic action as a disinfectant and as a deodorant than crude carbolic acid has.

For the efficient treatment of excreta, the surface should be completely covered with a film of saprol. This disinfectant offers an efficient protection against the danger of the transportation by flies of the infection of cholera, typhoid fever, and dysentery.

In a second paper by Dr. Scheurlen[1] he considers some of the objections to the use of saprol which had appeared in some

1. Archiv für Hygiene, XIX., 347. 1893.

recent papers on the subject. Referring to Pfuhl's paper, he says that there are really only two disinfecting agents besides saprol which are practicable for the disinfection of privy vaults, —milk of lime and crude carbolic acid. Used as it was by Pfuhl for the disinfection of human excreta, when the liquids had been otherwise disposed of, he admits that milk of lime is an efficient agent. But this is far from the general condition of things.

In ordinary vaults, with a mixture of the fluid and solid excreta, the milk of lime sinks to the bottom without mixing with the contents. This is what the experiments of Pfuhl have shown. The mechanical mixing of the milk of lime with the contents of the vault is impracticable.

Referring to a paper by Anschütz, who recommends lysol instead of saprol for the disinfection of excreta, Scheurlen says that a comparison of the results obtained by Anschütz with the two agents is impossible.

He says that lysol is not a suitable disinfectant for excreta, for, when added to the contents of a vault that are in a fluid condition, the lysol is decomposed and an oily layer floats upon the surface. This finally condenses into a mass consisting of fatty acids and hydrocarbons soluble in ether and solutions of alkalis.

He refers also to Keiler's "soluble saprol" as another preparation which is equally inappropriate for the disinfection of fluid excreta.

Scheurlen made some experiments to determine the comparative value of saprol and of crude carbolic acid for the disinfection of excreta, particularly when it is in a fluid condition, and he found that, when not mixed mechanically, the fluids were capable of extracting a much larger proportion of cresol from saprol than from crude carbolic acid.

Referring to the paper of Pfuhl, Scheurlen claims that Pfuhl's results do correspond with his, so far as the experiments are comparable. He says that for the disinfection of fecal matter from which the fluids have been separated, saprol is not superior to some other agents, but is their equal; but when the contents of the vault are fluid or semi-fluid, saprol is greatly superior to any agent hitherto recommended for this purpose.

SILVER AND SILVER SALTS.

During his investigation of the antiseptic action of various filling material in dental work, Professor Miller, of Berlin, was surprised to find that gold-foil, in some of the forms used by dentists, has a distinct antiseptic action. The correctness of this observation was confirmed by Behring,[1] and he found that some other metals, notably metallic silver, possess a marked antiseptic action. Miller's theory, that their antiseptic properties were due to the condensation of oxygen or other gases upon their surfaces, is shown by Behring to be untenable, and that the antiseptic action is due to a slight degree of solubility of the metals and, consequently, to the presence in his cultures of a small quantity of the salts of these metals.

Actol and Itrol.—In an address by Dr. Credé,[2] of Dresden, he says that in common with his assistant, Dr. Beyer, they succeeded in proving that metallic silver, when placed upon aseptic, sterile wounds, remains unchanged and does not at all irritate, so that it may be considered in every respect a thorough aseptic dressing material. In case the wound is not aseptic, but is in any part infected by bacteria, the products of the bacterial vitality oxidize the surface of the silver and enter into combination with the argentic oxid, forming argentic albuminates which have strong antiseptic properties; in other words, a powerful antiseptic is at once formed by the aid of the aseptic metallic silver dressing as soon as the wound is already infected or becomes so. We succeeded in determining by a series of experimental researches that the bacterial secretion, acting upon silver and entering into combination with its oxids, are organic acids, preeminently lactic acid, and that the antiseptic which an infected wound, when dressed with metallic silver, generates of itself, is lactate of silver.

Lactate of silver (actol) is a white, odorless, almost tasteless powder, which, when kept in a brown glass vial, remains unchanged; it is soluble in the proportion of 1 to 15 parts in water and in albuminous fluids. In its aqueous solution, in the proportion of 1 : 1,000, it destroys within five minutes streptococci, staphylococci, bacillus anthracis, etc. In blood serum,

1. Zeit. für Hygiene, IX., 432. 1890.
2. Reported in Medical Review, XXXIV., 251. 1896.

it retards the development of bacterial germs in a dilution of 1:80,000, while corrosive sublimate does so only in a solution of 1:20,000. It has, therefore, an antiseptic power at least four times as great as that of corrosive sublimate.

He further states that the silver salts under consideration do not destroy cellular tissue as corrosive sublimate does while preventing the propagation of bacteria.

As stated before, when lactate of silver is employed in powder form, it exercises some irritating action upon the more sensitive tissues, because it is rapidly absorbed on account of its ready solubility; a toxic effect, therefore, is not quite excluded after a liberal and long continued application of the dry powder.

Of the other argentic salts, citrate of silver (itrol) proved to be the preferable and most efficient one in its action in bacteriological and clinical experimental researches. It forms a light, dusty, and stable powder without odor, and almost devoid of taste, and with the same antiseptic power as the lactate; but it requires 3,800 parts of water for solution. A solution of 1 part in 4,000 of water suffices to destroy all bacteria within ten minutes; its antiseptic power, therefore, is amply sufficient in all cases commonly occurring. It occasions no unpleasant or painful sensation in any kind of wound, and its scanty solubility secures for it a more lasting action with the advantage of a sparing application. Its use is, therefore, much cheaper than that of iodoform, although it is relatively about twice as dear.

Marx[1] shows experimentally that actol cannot be used as an antiseptic for the whole body. Not only were his results antiseptically negative, but moderate hypodermatic doses produced febrile temperatures, due, he thinks, to the systemic action of lactic acid, following the decomposition of actol into lactic acid and metallic silver. As to the local action of actol and itrol, he believes that the work of Credé and Beyer has been so exact and faultless that there can be no doubt of the great value of these agents as local antiseptics.

In another paper, Marx[2] reviews several late works upon the antiseptic action of the silver salts:

Zagontschkonski could observe no antiseptic action from silver gauze as recommended by Dr. Credé. He found that the

1, Centr. für Bak., XXI., 573. 1897.

2. Ibid., p. 711.

gauze itself contained germs. Beyer, on the other hand, had always found the silver gauze sterile and thought it probable that Zagontschkonski had obtained an old preparation which was prepared by the old and incomplete methods.

Meyer made careful and extended investigation of the action of the silver salts. He found that Staphylococcus pyogenes aureus was destroyed in forty-five minutes with a 1:4,000 solution of itrol, and in thirty minutes with a 1:2,000 solution of actol. When in albuminous media, the silver solutions were slower in their action. The growth of sporeless bacteria was delayed with 1:20,000 in ascites bouillon, and in 1:10,000 in blood serum. They thought that the power of actol and itrol in preventing bacterial growth of albuminous media is very nearly that of sublimate, while in watery solutions the sublimate has a much greater action.

Pilger considers the silver salts very efficient and harmless antiseptics that must supersede all other agents for this purpose. Commenting upon the recent literature on this subject, Marx thinks that the original statements of Credé and Beyer are confirmed, and that among the numerous antiseptics itrol and actol are to take a prominent place.

Tarnawski[1] studied the disinfecting and antiseptic properties of actol and itrol, and, at the same time, carried on a series of parallel experiments with sublimate and nitrate of silver for purposes of comparison. The bacteria used were typhoid bacilli, Staphylococcus pyogenes aureus, and anthrax spores. The growth of anthrax and of the staphylococcus was inhibited by 1:20,000 of either of these salts; while the development of typhoid bacilli was prevented by 1:30,000 of actol, and 1:40,000 of itrol. The antiseptic action of sublimate, however, exceeded that of the silver salts.

In his experiments to determine the germicidal action of these salts, he neutralized them with ammonium sulphid. Without this precaution, anthrax spores appear to be destroyed in from five to twelve hours with a 1 per cent. solution of silver nitrate or saturated solution of itrol, but when neutralization followed exposure to the disinfecting agent, they were not destroyed in 168 hours. Staphylococcus was destroyed in forty-eight hours with from 1:500 to 1:200 of actol solution, or in five hours

1, Centr. für Bak., XXIII., 618. 1898.

with a 1:100 solution. Some of the conclusions of the author are that:

In blood serum, actol is inferior to the nitrate of silver as a disinfectant; in bouillon, the difference is slighter. In serum, sublimate is much superior to the silver salts in disinfecting power.

Blumberg[1] finds that, so far as their antiseptic action on animal tissues is concerned, argentamin, actol, and itrol are superior to silver nitrate and argonin, and that mercuric chlorid is inferior to them.

Protargol.—This antiseptic is composed of silver combined with protein material. It contains 8 per cent. of metallic silver and is easily soluble in cold water to 50 per cent. The solutions are entirely clear. It is also soluble in blood serum and solutions containing albumen, and in glycerin. Solutions of protargol are not precipitated by albumen nor by sodium chlorid.

Benario[2] tested the bactericide action of protargol upon various bacteria. An aqueous suspension of Staphylococcus pyogenes aureus was sterilized in twenty minutes with 1 per cent., and, suspended in bouillon, the germs were destroyed in ten minutes. In both bouillon and serum, sterilization was more rapid than in sterilized water. Typhoid bacillus, bacterium coli, and Siegel's bacillus and the pneumococcus were destroyed still more readily than staphylococcus,—a 1 per cent. solution destroyed them in from five to seven minutes. Anthrax spores were destroyed in one hour with a 2 per cent. solution.

For installation into the conjunctival sac, or used otherwise, Benario found protargol devoid of irritating qualities. In his own hands, and in the hands of others, he states that protargol has been found to be a very desirable and efficient antiseptic.

On the other side of the question of the antiseptic value of protargol, Kaufmann and Bloch[3] subjected the methods of Benario to a severe criticism, and doubt the correctness of his conclusions.

Nitrate of Silver.—As regards the disinfectant power of nitrate of silver, Behring[4] places it next to that of mercuric chlorid, and in blood serum, in milk, or in albuminous fluids, its

1. Zeit. für Hygiene, XXVI., 201. 1898.
2. Deutsche Med. Woch., XXIII., 82 (Therap. Beil.). 1897.
3. Deutsche Med. Woch., XXIV., 27 (Therap. Beil.). 1898.
4. Zeit. für Hygiene, IX., 406. 1890.

action surpasses that of sublimate. Heider[1] had not found this agent so efficient a germicide as Behring had. Anthrax spores subjected to the action of a 1 per cent. solution of nitrate of silver were not killed in fifty-four hours. In a foot-note, Heider refers to Savor's results in which anthrax spores were killed in fifteen minutes with a 1 per cent. solution, but he used nothing to precipitate the silver salt which adhered to the spores.

In his tests of various disinfectants, Baer[2] found that in bouillon, sporeless anthrax cultures were sterilized in two hours with from 1:30,000 to 1:20,000; diphtheria, with from 1:10,000 to 1:2,500; glanders, with from 1:15,000 to 1:4,000; typhoid fever, with 1:4,000; cholera, with from 1:20,000 to 1:4,000. The first proportions were with freshly inoculated cultures; the second, with 24-hour cultures.

In his experimental investigation of the disinfectant action of nitrate of silver, Jerosch[3] found that anthrax bacilli on threads were destroyed in one minute by solutions of from 1:1,000 to 1:10,000. Similar results were obtained with Staphylococcus pyogenes aureus. He therefore rates the disinfectant action of nitrate of silver above that of carbolic acid.

SOAP.

The observations of Koch[4] that a 1 : 1,000 solution of potash soap in water prevented the development of anthrax bacilli, indicated that soap has a disinfecting as well as a cleansing action.

Behring[5] tested the disinfectant value of forty different samples of soap, usually in 10 per cent. solutions, and concluded that the germicide power of soaps depends upon their degree of alkalinity. Some other experimenters, however, do not agree with him on this point. So far as I know, Behring has published no detailed results.

The experiments of Nijland,[6] in sterilizing with soap water in which the cholera bacillus was suspended, yielded quite remarkable results. Suspensions of the bacillus were completely sterilized in ten minutes with 2.4:1,000 of potash soap

1. Archiv für Hygiene, XV., 357. 1892.
2. Zeit. für Hygiene, IX., 482. 1890.
3. Centr. für Bak., VII., 226. 1890.
4. Mittheil. a. d. Kais. Ges., I., 271. 1881.
5. Zeit. für Hygiene, IX., 414. 1890.
6. Archiv für Hygiene, XVIII., 335. 1893.

with a 1:100 solution. Some of the conclusions of the author are that:

In blood serum, actol is inferior to the nitrate of silver as a disinfectant; in bouillon, the difference is slighter. In serum, sublimate is much superior to the silver salts in disinfecting power.

Blumberg[1] finds that, so far as their antiseptic action on animal tissues is concerned, argentamin, actol, and itrol are superior to silver nitrate and argonin, and that mercuric chlorid is inferior to them.

Protargol.—This antiseptic is composed of silver combined with protein material. It contains 8 per cent. of metallic silver and is easily soluble in cold water to 50 per cent. The solutions are entirely clear. It is also soluble in blood serum and solutions containing albumen, and in glycerin. Solutions of protargol are not precipitated by albumen nor by sodium chlorid.

Benario[2] tested the bactericide action of protargol upon various bacteria. An aqueous suspension of Staphylococcus pyogenes aureus was sterilized in twenty minutes with 1 per cent., and, suspended in bouillon, the germs were destroyed in ten minutes. In both bouillon and serum, sterilization was more rapid than in sterilized water. Typhoid bacillus, bacterium coli, and Siegel's bacillus and the pneumococcus were destroyed still more readily than staphylococcus,—a 1 per cent. solution destroyed them in from five to seven minutes. Anthrax spores were destroyed in one hour with a 2 per cent. solution.

For installation into the conjunctival sac, or used otherwise, Benario found protargol devoid of irritating qualities. In his own hands, and in the hands of others, he states that protargol has been found to be a very desirable and efficient antiseptic.

On the other side of the question of the antiseptic value of protargol, Kaufmann and Bloch[3] subjected the methods of Benario to a severe criticism, and doubt the correctness of his conclusions.

Nitrate of Silver.—As regards the disinfectant power of nitrate of silver, Behring[4] places it next to that of mercuric chlorid, and in blood serum, in milk, or in albuminous fluids, its

1. Zeit. für Hygiene, XXVI., 201. 1898.
2. Deutsche Med. Woch., XXIII., 82 (Therap. Beil.). 1897.
3. Deutsche Med. Woch., XXIV., 27 (Therap. Beil.). 1898.
4. Zeit. für Hygiene, IX., 406. 1890.

action surpasses that of sublimate. Heider[1] had not found this agent so efficient a germicide as Behring had. Anthrax spores subjected to the action of a 1 per cent. solution of nitrate of silver were not killed in fifty-four hours. In a foot-note, Heider refers to Savor's results in which anthrax spores were killed in fifteen minutes with a 1 per cent. solution, but he used nothing to precipitate the silver salt which adhered to the spores.

In his tests of various disinfectants, Baer[2] found that in bouillon, sporeless anthrax cultures were sterilized in two hours with from 1:30,000 to 1:20,000; diphtheria, with from 1:10,000 to 1:2,500; glanders, with from 1:15,000 to 1:4,000; typhoid fever, with 1:4,000; cholera, with from 1:20,000 to 1:4,000. The first proportions were with freshly inoculated cultures; the second, with 24-hour cultures.

In his experimental investigation of the disinfectant action of nitrate of silver, Jerosch[3] found that anthrax bacilli on threads were destroyed in one minute by solutions of from 1:1,000 to 1:10,000. Similar results were obtained with Staphylococcus pyogenes aureus. He therefore rates the disinfectant action of nitrate of silver above that of carbolic acid.

SOAP.

The observations of Koch[4] that a 1:1,000 solution of potash soap in water prevented the development of anthrax bacilli, indicated that soap has a disinfecting as well as a cleansing action.

Behring[5] tested the disinfectant value of forty different samples of soap, usually in 10 per cent. solutions, and concluded that the germicide power of soaps depends upon their degree of alkalinity. Some other experimenters, however, do not agree with him on this point. So far as I know, Behring has published no detailed results.

The experiments of Nijland,[6] in sterilizing with soap water in which the cholera bacillus was suspended, yielded quite remarkable results. Suspensions of the bacillus were completely sterilized in ten minutes with 2.4:1,000 of potash soap

1. Archiv für Hygiene, XV., 357. 1892.
2. Zeit. für Hygiene, IX., 482. 1890.
3. Centr. für Bak., VII., 226. 1890.
4. Mittheil. a. d. Kais. Ges., I., 271. 1881.
5. Zeit. für Hygiene, IX., 414. 1890.
6. Archiv für Hygiene, XVIII., 335. 1893.

(green or soft soap). A soda soap (hard soap) in the same proportion did not fully sterilize in fifteen minutes, but a 3:1,000 solution sterilized within one minute.

Jolles[1] tested five kinds of soap, the degree of alkalinity of which varied from 0.02 per cent. to 0.05 per cent. His solutions ranged from 0.1 per cent. of soap to 10 per cent. He thinks that the results which he obtained justify the conclusion that there was very little difference in the disinfectant action of these soaps, when used in the same proportions, at the same temperature, and acting for equal periods of time. At the temperature of 15° C., a 9 per cent. solution of either of these soaps destroyed cholera bacilli in from one to two minutes; a 4 per cent. solution, in ten minutes; and a 2 per cent. solution, in thirty minutes.

A still more recent work is that of Reithoffer.[2]. The soaps used by him were the common soft soap, a white almond soap perfumed with nitrobenzol, and a hard patent potash soap. Suspensions of cholera bacilli were sterilized in one half minute with 10 per cent., and in five minutes with 5 or 2.5 per cent. Suspensions of typhoid bacilli were sterilized in one minute with 10 per cent. of soap, and in from three to ten minutes with 5 per cent. Staphylococcus pyogenes aureus was not killed in one hour with 18 to 20 per cent. Hence, in surgical practice, soap does not suffice as a disinfectant, but for the destruction of the typhoid bacillus and Bacterium coli commune, soap may be used when other disinfectants are not at hand.

Reithoffer says that soap of good quality must be used, and that the common soft soap of the market is often impure and not worth much.

The results obtained by Beyer[3] were far less favorable than those of the preceding investigators. One of the official regulations in Germany for the disinfection of the clothing and bed clothing of cholera patients in 1893, was to immerse these articles in a 3 per cent. solution of potash soap, a solution of carbolic soap, or of carbolic acid, and let them remain twenty-four hours in it. To determine the germicidal value of the first of these solutions thus used, Beyer instituted a series of experiments in which soaps of various kinds were applied to the disinfection of pieces of cloth infected with the cholera bacillus,

1. Zeit. für Hygiene, XV., 460. 1893.
2. Archiv für Hygiene, XXVII., 350. 1896.
3. Zeit. für Hygiene, XXII., 228. 1896.

typhoid bacillus, Bacterium coli commune, Staphylococcus pyogenes aureus, and the diphtheria bacillus. He sought to have the conditions approach as nearly as possible those in real practice. The soaps received from various manufacturers were sent in compliance with Beyer's request for green or potash soaps with an excess of alkalinity. Of the seven soaps examined, the proportion of free alkali varied from 0 to 0.096, and, as Kitasato has shown that cholera bacilli in neutral bouillon will bear as much as 0.237 per cent. of free soda or potash before growth ceases, and typhoid bacilli as much as 0.18, it is evident that if disinfection should result it could not be due to the presence of free alkali. The soap solution was used at various degrees of temperature, not exceeding 50° C.

The results indicate that a 3 per cent. solution of potash soap (green soap, soft soap) cannot be trusted to destroy even the bacillus of cholera, unless the infected samples were kept in the solution at a temperature of 50° C. (122° F.) for one hour at least, and then were allowed to macerate in it twenty-four hours longer. The destruction of the other bacteria required generally the maintenance of the temperature of 50° C. for a longer time and the prolongation of the period of soaking to forty-eight hours. In the treatment of soiled clothing, the temperature of the solution cannot be raised above 50° without danger of staining it, and it is practically impossible to bring the solution to the temperature of 50° in all parts of a boiler without exceeding that temperature in some parts.

Applied to the destruction of the bacillus of plague, Giaxa and Gosio[1] found that 5 per cent. of green soap at 15° C. had no effect in twenty-three hours; but that 3 per cent. at 35° did kill the bacilli.

Summary.—As may be seen under "Heat as an Auxiliary" and under "Alkalis," solutions of washing soda, when their temperatures are raised to 55° or 75° C. (131° or 167° F.), become prompt and efficient germicides. On the other hand, the review of the experiments with soap solutions reveal results and conclusions too discrepant to warrant the classification of such solutions as trustworthy disinfectants when the temperature is 50° C. (122° F.) or below.

1. Annali d'Igiene Sperim., VII., 261. 1896.

Solutions.—The Board of Health of New York City directs that one ounce of common soda be added to twelve quarts of hot soap (soft soap) and water, and for the present it will be on the safer side to prescribe, as that board does, that this solution is to be used for simple cleansing, or for cleansing after other methods of disinfection.

SOAPS, ANTISEPTIC.

Dr. Chas. T. McClintock[1] gives an account of his experiments as to the possibility of making an antiseptic soap in which mercurial salts remain in an active form and undecomposed. After narrating the results of various unsuccessful attempts in this line, he says:

"Turning to the iodids I was more successful. For example, a solution of the double salt of mercury and potassium iodid will permit the presence of a weak alkali without precipitation of the mercury. In such a solution albumens are dissolved; further, nickel and steel are protected by the alkali from the action of the mercury. This seemed to be what I was looking for, as it was a germicide more active than mercuric chlorid or iodid that would not tarnish instruments. But after making hundreds, even thousands of experiments with the material, it was not satisfactory. The trouble seemed to be in the amount of alkali needed: if too much was used, the mercury was precipitated; if too little, the metals were attacked. If the correct amount was employed at the outset, some of it might be used up uniting with albumens, for example, in disinfecting the skin.

"I next took advantage of the well known fact that when neutral soaps are dissolved in water they are gradually decomposed into acid soaps and free alkali. By combining my mercury salt with the soap, when this was dissolved, I got a gradually increasing amount of alkali sufficient to replace any used up by albuminous or other bodies present in the field of experiment. But some soaps, I found, liberated the alkali too rapidly, others too slowly. The amount of alkali and the rate of liberation depend, in part, on the nature of the oil from which the soap is made; also, to some extent, upon the amount of glycerin, free alkali, fatty acids, unsaponified fat adulteration, etc. After a long

1. Medical News, LXX., 485. 1897.

series of experiments to obtain the right kind of soap, the proper amount of the mercury salts, etc., I obtained a combination that appears to be fairly satisfactory. At first, I used a soap containing ½ per cent. of mercuric iodid; but, by varying the composition of the soap, I found I could use 1 per cent. and, later on, 2 per cent. of the mercury salt."

A series of tables give the results of his bacteriological tests of this soap. The solution containing 1 per cent. of the soap or 1:5,000 of mercuric iodid, killed cholera, typhoid, and diphtheria and Staphylococcus pyogenes aureus in one minute. A solution containing 0.2 per cent. of the soap, or 1:25,000 of mercuric iodid killed the micro-organisms of pus in fifteen minutes. A solution containing ¼ per cent. of soap, or 1:20,000 of mercuric iodid, killed Staphylococcus pyogenes aureus in one minute. A solution of soap containing 1:2,000 of mercuric iodid destroyed anthrax spores in one minute.

In these experiments, Geppert's precaution of precipitating with ammonium sulphid was observed. This antiseptic soap was tested after it had been exposed two months to sunlight. The results were as good as that of fresh material.

This soap does not attack nickel or steel instruments under any ordinary exposure. They may be boiled in a strong solution of it without harm. If left in the soap solution for some days, however, the instruments may rust.

The paper ends with the following conclusions:

1. In proportion to the amount of antiseptic contained, this soap is at least five times as strong as any known germicide. A 1 per cent. solution of the soap, 1:5,000 of mercuric iodid, is at least equal to 1:1,000 of mercuric chlorid. 2. As it would ordinarily be used, it is at least as strong as any germicide in common use: i. e., I believe that if a wet cake be rubbed over the hands, the layer of the soap next the skin will be at least a 1 per cent. solution, and as the tables show, this is at least as strong as 1:1,000 mercuric chlorid. 3. It does not coagulate albumens or attack nickeled or steel instruments. It does not seem to have any action on lead, and so will not injure waste-pipes. 4. It will not attack silver and aluminum instruments.

The correctness of the opinions of Dr. McClintock is confirmed by the results obtained by others, among whom are Dr.

F. G. Novy, of the University of Michigan, and Dr. W. M. L. Coplin, of Jefferson Medical College, Philadelphia. Dr. Novy reports:

"The peculiar combination in which the mercury exists in the soap renders it decidedly more efficient than the common mercury solutions. A soap solution containing 1 : 5,000 of mercuric iodid, acting on common pus-producing organisms, destroys these in less than five minutes, whereas solutions of mercuric chlorid (1 : 1,000, or mercuric iodid (1 :1,000) require more than fifteen and sixty minutes, respectively, to accomplish the same result.

"Another superiority of this soap solution, as compared with the common mercury solutions, is seen in the fact that steel and nickel instruments may be exposed to its action, at ordinary temperature or at steam heat for hours, without the slightest effect on such instruments.

"An additional and important advantage of the soap solution is seen in its behavior to chemical compounds which ordinarily throw mercury out of solution. The mercury contained in the soap solution is not precipitated by proteid matter (such as blood serum), by phosphates (as in urine), or by hydrogen sulphid. The soap solution can be used in the presence of such compounds, whereas ordinary mercuric solutions would be of little value. Thus, mercuric chlorid is not recommended for the disinfection of sputum in consumption, because it is precipitated by the proteid constituents. When the soap solution is added to tuberculous sputum the latter becomes gelatinous and in a short time perfectly liquid. The germicide can therefore act on the tubercle bacilli and does destroy these in a short time, as shown from experiments with guinea-pigs."

In Dr. Coplin's experiments, the germicidal soap was tested on bouillon cultures of anthrax, Staphylococcus pyogenes aureus, prodigiosus, pyocyaneus, and on pus containing staphylococci. With 1 per cent. of the soap, which is equivalent to 1 : 5,000 of mercury iodid, all were destroyed in three minutes; all but the pus in two minutes; all but anthrax and pus in one minute; and all but anthrax in half a minute.

With 1 : 1,000 of mercuric chlorid for comparison, the pus was not sterilized in eight minutes; only Staphylococcus pyo-

genes aureus and prodigiosus in five minutes; and not one was sterilized in three minutes.

With 5 per cent. carbolic acid, anthrax and pyocyaneus remained unsterilized after eight minutes; only the pus in five minutes; and none in three minutes.[1]

SODA. (See ALKALIS.)

SODIUM HYPOCHLORITE.

Dr. Duggan,[2] for the committee on disinfectants, finds this to be a rapid and efficient disinfectant. "A solution containing 0.25 of 1 per cent. (1 part to 400) of chlorin, as hypochlorite, is an effective germicide, even when allowed to act for only one or two minutes, while 0.006 of 1 per cent. (6 parts to 10,000) will kill spores of B. anthracis and B. subtilis in two hours." One of the solutions of sodium hypochlorite used by Dr. Duggan, made by passing chlorin gas into a solution of sodium hydroxid, contained 6 per cent. of available chlorin. He says of this solution that "although rather concentrated and frequently exposed to the light and air, it has kept for a month without any appreciable change. A solution like this might be put on the market at a very reasonable price, and, as it should be diluted with 20 parts of water, it would be far cheaper and more effective than any of the proprietary disinfectants." The committee on disinfection recommends a solution of chlorinated soda, diluted with 9 part of water, for the disinfection of the surfaces of the bodies of sick persons, or of their attendants when soiled with infectious discharges.

Klein[3] made a series of experiments with sodium hypochlorite, using as test-organisms Bacillus coli communis, B. typhosus, B. diphtheriae, bacillus of swine fever, cholera bacillus, Staphylococcus pyogenes aureus, anthrax spores, and spores of Bacillus enteritidis. A 10 per cent. solution containing 1 per cent. of available chlorin destroyed all of the microbes in twenty

1. The reports of Drs. Novy and Coplin were received through the courtesy of Parke, Davis and Co.

2. Tr. Am. Public Health Association, XI., 200. 1886.

3. Lancet, II., 1896, 509.

minutes, and in ten minutes none of the sporeless bacteria were alive.

A 1 per cent. solution with 0.1 per cent. of available chlorin destroyed all of the sporeless organisms, but the two sporing bacilli were not sterilized in twenty minutes. Added to sewage, 1 per cent. of sodium hypochlorite sufficed to devitalize the sporeless microbes of sewage in ten minutes.

In his experiments for the determination of the value of disinfectants for excreta, Vincent[1] found that Labarraque's solution is a little less active than the saturated solution of chlorid of lime. To destroy the bacillus of typhoid fever in typhoid stools, a quantity equal to 18 per cent. of its volume must be added if the destruction is to be accomplished in twelve hours.

Dr. Henry Leffman,[2] of Philadelphia, made an investigation of chlorinated lime and chlorinated soda as they are found upon the market.

Six samples of solution of chlorinated soda varied from 1.06 to 2.48 per cent. of available chlorin, and of eight samples of chlorinated lime, in packages, the available chlorin varied from 20 to 33 per cent.

He says that in justice to the dealer it should be mentioned that these preparations are subject to steady deterioration, not only through the influence of the moisture and carbon dioxid of the atmosphere which forms carbonates and liberates the hypochlorous acid, but a slow conversion into chlorate also occurs in a manner not thoroughly understood, and this change also reduces the available chlorin.

In hospitals and wherever there is intelligent aid available, it will be economical to prepare the sodium solution directly from the commercial chlorinated lime of good quality, using the following formula, approximately that of the U. S. P. 1870:

Chlorinated lime, 1 pound.
Washing-soda, 2 pounds.
Water, 2 gallons.

In making solutions of chlorinated lime, it is best to triturate the article with water to the consistency of thick cream and then diffuse this mixture in a larger volume. If a mass of the material is simply shaken up with water it will not dissolve. In this

1. An. de l'Inst. Past., IX., 15. 1895.
2. Medical News, LXII., 595. 1893.

connection it may be well to note that good chlorinated lime is a nearly inodorous powder. If it is lumpy or pasty, or has a strong chlorin odor, it is somewhat decomposed.

SOLUTOL.

This is a cresol preparation for general disinfection in which the cresol is rendered soluble by the addition of cresol-alkali. The manufacturer claims that it has a constant strength of 60 per cent. of cresol. For ordinary use, crude solutol is recommended as cheap and effective. Pure solutol may be used in dwelling-houses or wherever the odor of the crude solutol would be offensive.

In Buttersack's[1] experiments for the Imperial Board of Health of Germany, solutol was found to be much more effective than carbolic acid, or lysol, or any of the other cresol preparations. Crude solutol was the only preparation tested by him which proved capable of destroying anthrax spores in one day. Buttersack, therefore, says that, among all these agents, crude solutol alone answers the requirements of rapid and trustworthy disinfection in the most difficult cases.

According to Hueppe,[2] solutol penetrates organic matter more rapidly than lysol and is a better deodorant. The destruction of anthrax spores with creolin, lysol, solveol, or carbolic acid requires weeks: to destroy spores in twenty-four hours, or less, only corrosive sublimate, the acid solutions of cresol and the solutols are capable of doing it. The results of experiments in the laboratory of Hueppe have taught him that crude solutol answers all the requirements of gross disinfection, and is far more efficient than lysol. Taking everything into consideration, solutol, and particularly, crude solutol, is the best agent we have.

Gruber,[3] while admitting that solutol has decided disinfectant power, could not observe so energetic an action as some experimenters have reported. Solutol is deemed less efficient than "milk of lime" or soap solutions of cresol.

Comparing solutol with lysol, H. Koch noticed that solutol penetrates more rapidly into the interior of masses of matter

1. Arbeiten a. d. Kais. Ges., VIII., 369. 1892.
2. Berliner Klin. Woch., 1893, No. 21. (Reprint.).
3. Centr. für Bak.. XV., 1021. 1894.

and thus overcomes the foul odors more speedily. In twenty-four hours, solutol dissolved blood coagula more completely than lysol did. According to Koch, solutol is the preferable disinfecting agent for slaughter-houses and stables. It is more efficient and it is cheaper. A 0.5 per cent. solution is clear and sufficient for ordinary disinfection.

Seifert,[1] comparing the action of the various disinfectants, strongly recommends solutol on account of its efficiency and low cost.

Comparing the action of solutions of lysol, solveol, and of solutol, each containing 5 per cent. of cresol, and kept at a temperature of 55° C., Heider[2] observed that anthrax spores were destroyed by lysol in five hours, by solveol in two hours, and by solutol in one hour.

Hammerl[3] says: "In solutol the germicidal effect of the cresol is increased by the strong alkaline reaction of the preparation. It is well suited for gross disinfection."

The work of Vincent[4] indicated that solutol is very similar in its action to that of solveol, and that possibly it is a little inferior in its action.

Solutions.—The instructions of the manufacturer are to mix about half a pint of solutol with 2 or 3 gallons of water, preferably using the solution hot. A solution containing 1 per cent. of cresol must needs have about 1.7 per cent. of solutol.

SOLVEOL.

Solveol is a preparation of cresol held in an aqueous solution by means of cresotinate of soda. It contains 27 per cent. of cresol, and is prepared particularly as a surgical antiseptic. The claims of the manufacturers are: that it forms clear and perfectly neutral solutions in water; that solutions of the same effective strength are twenty times less poisonous and much less caustic than those of carbolic acid; that its solutions do not roughen the hands as corrosive sublimate does, nor benumb them as carbolic acid does, nor render them slippery as lysol does, nor obscure the field of operation as the precipitate of

1. Deutsche Viert. für öff. Ges. (Sup.), XXVIII., 262. 1897.
2. Archiv für Hygiene, XV., 370. 1892.
3. Archiv für Hygiene, XXI., 196. 1894.
4. Annales de l'Inst. Past., IX., 29. 1895.

creolin does; that its odor is less persistent than that of carbolic acid; and that, diluted with calcareous waters, precipitates are not formed as with corrosive sublimate and lysol: hence its solutions may be made with water from wells and cisterns. These claims seem to have been fairly well substantiated by various investigators.

In a comparative examination of the disinfectant powers of the cresols, Hammerl found that they are more efficient when rendered soluble by cresotinate of soda (solveol). In a later work,[1] he has compared solveol with other cresol preparations and with carbolic acid and finds that it is superior to all of them.

In his experiments with cresol rendered soluble with cresotinate of soda (solveol), Hammer[2] determined that solutions containing 0.5 per cent. of cresol act more energetically than 2.5 per cent. solutions of creolin, lysol, or carbolic acid.

He recommends it as a surgical antiseptic to supersede carbolic acid which is not always trustworthy.

Vincent[3] refers to the work of Hueppe, Hammer, Von Heyden, Koch, and Hagen, which indicate that solveol is a little more active than lysol and the other preparations of cresol. He states, however, that solveol appears to him to be a little inferior to lysol and cresol. It may be added that his experiments were in the disinfection of excreta, a use to which the manufacturers never intended solveol to apply. Nevertheless, Vincent says that the bacillus of typhoid in fecal matter was destroyed in seven hours with a 1 per cent. solution. Another mistaken use of solveol was apparently, that Buttersack[4] when he employed it for the disinfection of fresh tuberculous sputum. He, however, found that a 6.6 per cent. solution was very efficient and that it acted more promptly than carbolic acid. He might have used *solutol* for that purpose, another preparation of the same manufacturers intended for gross disinfection.

After using solveol nine months for all purposes as an antiseptic in medical and surgical practice, Hiller[5] says that it is the most desirable antiseptic that has yet come to his hands. In

1. Archiev für Hygiene, XXI., 198. 1894.
2. Archiv für Hygiene, XII., 359. 1891.
3. Annales l'Inst. Past., IX., 27. 1895.
4. Arbeiten a. d. Kais. Ges., VIII., 371. 1892.
5. Deutsche Med. Woch., XVIII., 841. 1892.

making a 1 per cent. solution, he mixes 37 cubic centimetres with 1 litre of well or hydrant water. In surgical work, one half of this strength suffices, for it is equal to a 2.5 or 3 per cent. solution of carbolic acid. This solution is at first clear, but after standing some days becomes slightly opalescent. It is entirely neutral, mixes with blood or pus without coagulating them, and produces no precipitate with other fluids or secretions. Its irritation of the skin or serous or mucous membranes is slighter than that of solutions of carbolic acid or corrosive sublimate of equal effectiveness. With his experience with it, Hiller holds that solveol is eminently suitable for use in connection with operations in the thoracic or abdominal cavities, and in gynecologic and obstetric practice. On account of its slight irritation, its relatively slight toxicity, and the certainty of its antiseptic action, no antiseptic hitherto used equals or exceeds it.

Hueppe,[1] under whose direction solveol was tested by Hammer, recommends it as an antiseptic, and thinks it may well replace those more toxic and irritating agents, carbolic acid and sublimate. Comparing it with lysol in the disinfection of the hands, when lysol is used the soap and the disinfectant constituent must act at the same time and for an equal length of time, then the hands must be rinsed in sterilized water, then dried. Water and soap are found everywhere for the primary cleansing but not sterilized water. If, however, we choose solveol, the hands are first washed in soap and water, solveol is used, and the hands are immediately dried as with carbolic acid or sublimate.

In a communication by Dr. Freund[2] on the use of solveol as an antiseptic in obstetric and gynecologic work, he states that for the past three months he has used solveol as the only antiseptic.

Pouring 37 cubic centimetres of solveol into 2,000 cubic centimetres of water gives us a solution containing ½ per cent. of cresol. This solution is almost as clear as water itself, and is in no way injurious to instruments. On the other hand, lysol and creolin mixed with water do not give clear solutions.

In connection with fifty births and a long series of gynecological cases, no fact has been encountered which has a tendency

1. Berliner Klin. Woch., 1893, No. 21. (Reprint.).
2. Archiv für öff. Gesund. in Elsass-Lothringen., XV., 19. 1893.

to throw any doubt upon the certain and energetic disinfecting power of solveol. One test of its use is that, used freely, no toxic symptoms have appeared. It causes no precipitates.

One disadvantage only has been noticed: when the hands are in contact with this solution for some time, the skin is roughened as in using solutions of carbolic acid, and slight sensations of numbness have sometimes been observed.

Solutions.—A 1 per cent. solution can be made by mixing 37 cc. of solveol with 1 litre of water, or approximately 1 per cent. by adding 2 ounces of solveol to 3½ pints of water. The ½ per cent. solution generally used can be formed by adding 18.5 cc. of solveol to 1,000 cc. of water.

SOZOIODOL PREPARATIONS.

Dr. Spirig,[1] of Bern, found that mercury-sozoiodol was more efficient as an antiseptic and a germicide than any of the other sozoiodol preparations. In all of his tests it ranked as the equal of sublimate. His conclusions are that the antiseptic action of potassium-sozoiodol upon wounds is better than in reagent glasses. One of the advantages of its use is that it is odorless, that it irritates the tissues but little, that on account of its slight degree of solubility it covers the surfaces for some time, and that the danger of poisoning during its use is slight. He thinks, however, that this agent does not equal iodoform in open wounds, but that it is worthy of a more extended testing.

Dräer[2] made a study of the antiseptic action of the various sozoiodol salts when applied to the bacillus of diphtheria. His results indicate that the mercury salt is the most efficient. A 1 per cent. solution sterilized in one half hour a well developed bouillon culture of this bacillus. An aqueous solution of the only slightly soluble mercury salt was made by adding common salt in the proportion of 7.5 : 1,000. In another table he shows that mercury sozoiodol sterilized a twenty-four hour bouillon culture of the diphtheria bacillus in five minutes with only 1 : 10,000 of the disinfecting agent.

Dräer recommends this agent as a topical application in the treatment of diphtheria, particularly when applied in powder

1. Zeit. für Hygiene, XIII., 15. 1893.
2. Deutsche Med. Woch., XX., 567, 583. 1894.

form in the mixture hydrarg. soz., natr. chlorat. ana 1.0, sulph. praecip. ad 50.0. Next to the mercurial salt, acid sozoiodol was the most active, then the zinc and the soda salt. The potassium salt was the least effective.

Professor Sormani[1] reports that the agent which was found by him in his experiments to destroy the bacillus of diphtheria the most rapidly is mercury-sozoiodol. As a stock solution to be applied to the throat, he dissolves 2 grams of this salt, with 1 gram of saccharin, and 50 grams each of alcohol and distilled water and adds 20 drops of hydrochloric acid. A single drop of this mixture sterilizes in less than a minute two cubic centimetres of very resistant cultures of the diphtheria bacillus.

As a local application to the throat, he applies this solution pure, or diluted in from five to fifty times its volume of water. Professor Sormani found the mercury salt much more active than the other sozoiodol salts.

Schwarz[2] also finds the mercury salt much more efficient than the other sozoiodol preparations, applying it locally with a powder blower. His statement, that mercury sozoiodol 1 : 10,000 quickly destroys the bacillus of diphtheria, confirms that of Dräer.

SPRAYING.

As a disinfecting process, spraying with solutions of various disinfectants has been recommended and used, especially for walls, floors, and upholstered furniture.

In 1884, under the advice of Dr. Joseph Holt,[3] President of the State Board of Health of Louisiana, spraying with a 1 : 1,000 solution of corrosive sublimate with muriate of ammonia to render the mercurial salt more soluble, was adopted as an important part of the sanitary treatment of vessels in quarantine. The solution was applied through a hose and rose to all of the available surfaces of the vessel, excepting cargo, but including bilge, ballast, hold, saloons, forecastle, decks, etc. Since then this practice has been widely extended in maritime quarantine work.

For the disinfection of the walls of rooms Guttmann and Merke, of Berlin, recommended spraying with a 1 : 1,000 solu-

1. Atti dell' Assoc. M. Lomb.—Revue D'Hygiene, XVIII., 74. 1896.
2. Wiener Klin. Woch.—Centr. für Bak., XIX., 19. 1896.
3. Rpt. of Com. on Disinfectants of A. P. H. Assoc. p. 215. 1888.

tion of corrosive sublimate. They used anthrax spores on threads. Their results were not an absolute sterilization of the walls; but the test was a severer one than is found in real work.[1]

Later Merke expressed the opinion that Esmarch's method of rubbing with bread is more trustworthy.[2]

Cronberg[3] refers to Guttmann and Merke's method as effective, cheap, and easily applied. He says it does not injure the walls and is not dangerous to the operator or the inhabitants of the room.

In various European countries, spraying with corrosive sublimate solution has been revived with satisfactory results, particularly in some of the English, French, and Italian cities. "In Paris, for instance, spray disinfection has been substituted for sulphur fumigation for some time; and last year the late M. Dujardin-Beaumetz, who at an earlier period had supported the use of sulphur fumigation, pointed out that the spray process gave a security to municipal disinfection which it had never previously had. Using a solution of 1 in 1,000 of mercury perchlorid, with either 2 per 1,000 of salt or from 3 to 5 per 1,000 of tartaric acid, it was found that house epidemics and reinfection were practically abolished. This result was first stated after over 100,000 disinfections had been carried out with the spray; and it was stated at the same time that prior to its adoption house epidemics and reinfection had been extremely common."[4]

Gerlach[5] experimented with lysol as a spray. In forty instances only two were unsatisfactory.

Of late, spraying with solutions of formaldehyde of various strengths has been recommended. Nils England uses a 2 per cent. solution, and a 2 per cent. or 2.5 per cent. solution is used by some of the English medical officers of health. Dr. Rideal recommends a 0.5 per cent., and Dr. Wyatt Johnston[6] a ½ to 1 per cent.

1. Jahresbericht ueber die Fortsch. und Leistung. a. der Geb. d. Hyg., V., 172. 1887.
2. Deutsche Viert. für öff. Ges., XXIII., 259, 274. 1891.
3. Archiv für Hygiene, XIII., 294. 1891.
4. Jr. of State Medicine, IV., 21. 1896.
5. Deutsche Viert. f. öff. Ges., XXIII., 148. 1891.
6. Reprint from Brit. Med. Jr., Dec. 25, 1897.

STEAM DISINFECTION.

Nothing is here given under this important heading for the reason that time has not been available for arranging the notes which have been collected on this subject. For a statement of the results obtained in some experiments with steam disinfection up to 1889, see pages 261-269 of the Fifth Annual Report of this Board. Evidence will there be found that pressure steam is not an essential of trustworthy steam disinfection. All pathogenic germs may be destroyed with certainty with current steam under very slight, or no pressure. The non-recognition of this fact has done more than anything else to defer the general use of steam disinfection in country districts, villages, and small cities.

SULPHATE OF IRON. (See FERROUS SULPHATE.)

SULPHUR FUMIGATION.

The experiments of Koch[1] show that, in a practically gas-tight casket, 1 per cent. by volume of sulphur dioxid will kill dry anthrax bacilli in twenty minutes when on threads and exposed to the direct influence of the gas, and that, under the same conditions, the bacilli are destroyed in two minutes when the threads are damp. Anthrax spores, however, were wholly uninjured by a four days' exposure to 6 per cent. of the gas. When dried cultures of sporeless bacteria, not more than from one tenth to one half millimetre thick, were exposed in a room fifty hours to sulphur dioxid, none were killed. One hour after the sulphur was lighted the percentage of sulphur in the air was about 3; one hour later it was only 1.25; and twenty hours later, 0.015.

The very extensive and careful experimental work of Wolffhügel[2] presented results similar to those of Koch. The action of the gas was only superficial, and in the disinfection of ordinary rooms its action, even upon sporeless bacteria, was very unfavorable. The German Cholera Commission prescribed 0.69; von Pettenkofer, 1.04; Mehlhausen, 1.39; and Wernich, 4 per cent. as the required proportion of the sulphur dioxid gas.

1. Mittheil. a. d. Kais. Ges., I., 252. 1881.
2. Ibid., p. 191-232.

In some of Wolffhügel's experiments more than 8 per cent. was present in the room at first, but in from two to four hours the air contained only 1.25, and in from twenty-one to twenty-seven hours it had only 0.02 per cent. by volume. Basing his opinion upon his experiments, the conclusion reached by him is that the idea of disinfecting goods with sulphur dioxid without injury is illusory.

In Sternberg's experiments,[1] sporeless bacteria were destroyed under favorable conditions, but he admits that "the conditions of success are such that it appears almost impracticable to conform with them in practice on a large scale, and it is evident that much of the so-called 'disinfection' with this agent is a farce." A suggestion of the reason why the Committee on Disinfection of the American Public Health Association retained sulphur fumigation as a disinfecting process may undoubtedly be discovered in this sentence from Sternberg's report: "We must not then be too exacting with reference to this agent until we are able to recommend something better in its place for the purposes to which it is commonly applied, viz., for the disinfection of apartments and ships."

Since the investigations of Koch and Wolffhügel were made, sulphur dioxid has been used but very little in Germany as a disinfectant; but in England and in France and some of the other Continental countries, its use has continued. Among the French investigators there has been no unanimity as to the efficiency of sulphur fumigation.

The experiments of Thoinot[2] were conducted in a room of 50 cubic metres capacity, the cracks and crevices being closed as tightly as possible with putty. The infectious material used was partly in the form of pathological secretions and pieces of organs, and partly pure cultures. The results showed that pathogenic bacteria, so far as regards the action of sulphur dioxid, may be divided into two groups. One group,—bacillus of malignant edema, sympathetic anthrax, and anthrax,—showed absolute resistance to the most concentrated and prolonged action of sulphur dioxid; while in the other group,—tuberculosis, glanders, typhoid fever, cholera, diphtheria,—sulphur dioxid has a disinfectant action.

1. Disinfection and Disinfectants, p. 64. 1888. Concord.
2. Étude sur la Disinfection par l'Acide Sulfureux, p. 7. 1890.

The required quantity for successful disinfection varies in different cases, but 60 grams of sulphur burned for each cubic metre of space, and allowed to act twenty-four hours in a well-closed room, gives, according to the author, absolute security. This quantity is, therefore, recommended in practice. (Wolffhügel found that twice this quantity cannot be trusted to destroy even sporeless infection in room disinfection.—Y.)

The tubercle bacilli used by Thoinot were partly in pure cultures, and partly in tuberculous sputum, and the latter was in a moist as well as in a dry condition. The subsequent inoculation into guinea-pigs gave negative results. The thickness of the layers of sputum subjected to the action of sulphur dioxid is not stated.

The conclusions of Dubief and Brühl[1] are favorable to sulphur dioxid as a disinfectant, but their methods were faulty and did not conform with the conditions found in actual practice.

In his paper on sulphur fumigation, Richard[2] adduces some testimony from the records of the military and naval surgeons in favor of the practice. By its use outbreaks of various diseases appear to have been stayed. Nevertheless, he affirms that, as sulphur dioxid occupies an inferior position in the list of the disinfectants, it should be employed only in those cases where other disinfectants are inapplicable, and he says that we continue to use sulphurous acid where other more trustworthy procedures are absolutely impracticable.

In the discussion which followed the reading of Richard's paper, Vallin supported the use of this process of disinfection, but would prescribe the previous liberation of a large quantity of steam in the room to be disinfected, by boiling water in open vessels of large area for one hour.

In an investigation of the comparative merits of sulphur and formaldehyde fumigation, made by Dr. Novy[3] for the State Board of Health of Michigan, the results were decidedly in favor of formaldehyde as the more efficient. The room used was designed as the disinfection room at the time the laboratory was built, and it was intended to have a capacity of 1,000 cubic feet, but slightly exceeded that. In order to make the room

1. Comptes Rendus.—Centr. für Bak., VI., 91. 1889.
2. Revue D'Hygiene, IX., 278. 1887.
3. Medical News, LXXII., 641. 1898.

perfectly tight, the aim in the construction of it was to have it gas-tight as nearly as possible, and was, therefore, much more nearly so than in the rooms found in ordinary disinfecting work.

It was found that formaldehyde does not tend to pass out of the rooms so rapidly as sulphur dioxid does, and therefore has a distinct advantage over sulphur in the disinfection of crowded tenement-houses. As to the germicidal powers of the two gases, it was found that sulphur fumes possessed little or no action on most bacteria when in the dried state. If, however, the specimens are actually wet, they will be destroyed except in the state of the resistant forms, such as the spore stage and tubercle bacilli. For tubercle bacilli or spore-containing material, wet or dry, it is of no value. It can be used for the diisnfection of rooms which have been infected with ordinary disease organisms. From three to six pounds of sulphur must be burned in each 1,000 cubic feet of space. The evaporation of water in the rooms where the articles are to be disinfected does not suffice. The walls, floors, and articles in the room should be sprayed with water. The room should be made perfectly tight, and should be kept closed at least twenty hours.

While sulphur fumigation under certain conditions is of value, it is, nevertheless, evident that it is more obnoxious to persons in adjoining rooms, more injurious to fabrics, and certainly less effective than formaldehyde.

Professor Robinson made a single comparative experiment with sulphur in one of the rooms used in the formaldehyde experiments. The results were decidedly unfavorable to sulphur dioxid.[1]

The citing of a larger number of works on the subject would serve in no degree to change what must be considered the just verdict,—that, though sulphur dioxid has some germicidal power when tested on sporeless bacteria, it is an untrustworthy agent in the disinfection of rooms and their contents.

Other Objections.—The action of sulphur dioxid is increased by having the goods to be disinfected moistened by the diffusion of watery vapor in the air. At the same time its injurious action upon many articles is increased. Some of the ill effects observed in the extensive practice of the Marine Hospital Service, as

1. This Report. p. 167.

record by Surgeon Carter,[1] are: It injures the colors of many woolen goods, being especially hard upon greens and bright reds. A red flannel shirt, for instance, always comes out yellow. The dark blues are generally uninjured, but sometimes turn a reddish brown. Articles containing starch, if not washed soon, are corroded, especially true of handkerchiefs. Blankets and hair pillows will retain, for about a week, a smell so disagreeable, in no sense like that of burning sulphur, that they are unpleasant to use. Flour in ordinary barrels will not rise with yeast for some days after exposure. Tea and coffee are permanently ruined. Apples and other fruits are made worthless. Metals are tarnished. Further objections to the use of this gas are that it is an active poison, and it is dangerous to inhale it even when not highly concentrated; that it leaves an unpleasant odor in rooms in which it has been used; and that, in its use, there is some risk of fire.

Comparison with Other Gaseous Disinfectants.—While the disinfectant power of chlorin gas is somewhat greater than that of sulphurous acid gas, the corrosive action of chlorin is greater, and it bleaches and destroys fabrics in a greater degree than sulphurous acid. The disadvantages of chlorin are so great that it has filled but a small place in general disinfecting practice.

On the other hand, formaldehyde has distinct advantages over sulphur dioxid, in being a much more efficient germicide. Many investigators have demonstrated that, when well exposed, anthrax spores are destroyed by formaldehyde. Formaldhyde appears to have, also, a somewhat greater power of penetration, it is practically without injurious action upon the colors or textures of fabrics, its inhalation in any quantity likely to be received, is free from danger, and its odor is much less disagreeable than that of the fumes of sulphur.

SURGICAL ANTISEPTICS.

Carbolic acid, the chief reliance in the early days of antiseptic surgery, is now largely replaced by other agents of greater germicidal activity, or less toxic, or for other reasons deemed more desirable. Scheurlen, Beckmann, and Römer have shown that the antiseptic action of solutions of carbolic acid and the cresols

1. Jr. Amer. Med. Assoc., 367, XIV, 518. 1890.

is increased by the addition of common salt to them. (See Carbolic Acid.)

The cresols, so the results got by most of the experimenters indicate, are superior to carbolic acid. In his experiments, Gruber discovered that an aqueous solution of cresol made by shaking crude carbolic acid with water has remarkable antiseptic powers. (See Cresol—*Surgical.*)

Some recent investigations made by Loeffler indicate that solutions of anytols of carbolic acid, or of the cresols, are more energetic in their action than the simple solutions. (See Anytin and Anytols.)

The preponderance of evidence indicates that lysol is more efficient than carbolic acid and, in common with the other cresol preparations, is less toxic. An inconvenience in its use is that hands and instruments are rendered slippery.

Solveol, a somewhat recent addition to the list of cresol preparations, is designed particularly as a surgical antiseptic. It forms clear solutions in water, it is less toxic than carbolic acid, it does not render objects slippery, and it is more efficient than carbolic acid. (See Solveol.)

Phenosalyl, according to Christmas and Fränkel, is a desirable antiseptic and superior to carbolic acid.

The work of Pane indicates that thymol is a valuable antiseptic. Its action when applied to Staphylococcus pyogenes aureus is especially energetic. He recommends a 1 : 1,000 solution.

Mercuric chlorid, a very energetic antiseptic in non-albuminous solutions, is untrustworthy when brought in contact with albuminous matter, as occurs in most surgical work. The additional disadvantages, that it is highly toxic and that it corrodes instruments, still further impair its value as a surgical antiseptic. (See Mercuric Chlorid—*Antiseptic Value.*)

Boric acid is very feeble in its action. It is often used where agents with more distinct antiseptic qualities are required.

Though antiseptic soaps generally are of doubtful value in general surgery, a "germicidal soap" containing mercuric iodid and prepared by Parke, Davis & Co. appears, according to the tests of Drs. McClintock, Novy, and Coplin, to be a rapidly efficient and valuable antiseptic. (See Soaps, Antiseptic.)

Iodoform, though showing very little of the qualities of a germicide, exerts its antiseptic action in those classes of wounds

where antiseptics are most needed, as is stated under "Iodoform."

Iodin trichlorid acts rapidly as a germicide. A 1 : 1,200 solution inhibits the growth of pus bacteria.

The fact has been well established in laboratory and clinical work that some of the chemically pure anilin colors have a distinct antiseptic action even in weak solutions. (See Anilin Dyes.)

The work lately done by Credé and others makes it probable that itrol, actol, and other silver salts are to take a prominent place among the numerous surgical antiseptics. (See Silver Salts.)

Formaldehyde is a very energetic antiseptic. In addition to its anti-germicide action, distinct antitoxic affects probably follow its application to septic surfaces; but the range of the applicability of the various formaldehyde preparations, solid and liquid, is still to be determined. Thomalla, of Berlin, adds 5 per cent. polymerized formaldehyde to iodoform and finds the mixture much more efficient than iodoform alone. (See Formaldehyde—*Local Antiseptic and Therapeutic Action.*)

THYMOL.

According to Koch,[1] 1 :80,000 of thymol begins to check the growth of anthrax bacilli. Behring[2] found that thymol is not a trustworthy disinfectant,—that it is about four times weaker in its action than carbolic acid.

Perroncito learned that a saturated aqueous solution of thymol killed anthrax bacilli in from six to ten minutes, but that it had no action upon anthrax spores.

Pane[3] found that, other than a retardation of their growth, anthrax spores were uninfluenced by a solution of 2 :1,000, acting seven days at a temperature of 35°.

Staphylococcus pyogenes aureus, however, was more sensitive to much weaker solutions: indeed, this bacterium dried on threads was sterilized in from ten to fifteen minutes with a solution of 1 :1,000 at a temperature of 37°, and a solution of 1 :2,000

1. Mittheilungen aus dem Kais. Ges., I., 271. 1881.
2. Zeit. für Hyg., IX., 423. 1890.
3. An. dell' Istituto D'Ig. Sperimentale dell'Univ. di Roma, II., 81. 1890.

produced the same effect at the same temperature in thirty minutes, and at the temperature of 15°, in one hour. With the method of Esmarch, the 1:1,000 solution is still more efficient, for at 37° sterilization is effected in from a minimum of two to five minutes to a maximum of ten to fifteen minutes.

This result is superior to that obtained by the same method with sublimate solutions in equal proportions. This energetic action of thymol upon Staphylococcus pyogenes aureus, and its acting more efficiently upon the germs in Esmarch's method than when they are upon threads, Pane deems worthy of note.

Pane's solutions of thymol were made with distilled water. He says that when ordinary water is used the solution must be stronger to obtain equal effects.

In view of the energetic action of thymol upon Staphylococcus pyogenes aureus, Pane thinks that the use of the 1:1,000 solution merits a wider adoption in surgical practice, particularly in the major operations, laporotomies, etc. When it is used the solutions should be warmed. It has the advantage, also, of cheapness and absence of unpleasant odors.

TUBERCULOSIS.

The principal problems presented in the disinfection required under this heading are the treatment of fresh tuberculous sputum; dried tuberculous sputum, or tuberculous dust; and tuberculous milk. The difficulty in destroying the tubercle bacillus under these various conditions differs considerably.

Fresh Tuberculous Sputum.—The experiments of Schill and Fischer[1] led them to conclude that but very few chemical disinfectants are capable of destroying fresh tubercle bacilli. In fresh, moist sputum, they were killed in fifteen minutes by flowing steam at 100° C.; in ten minutes by boiling in water; in twenty-four hours with a 5 per cent. solution of carbolic acid in equal quantities. The bacilli were not killed in twenty-four hours with a 1:1,000 nor with a 1:500 solution of corrosive sublimate. Dried sputum, however, was destroyed with 1:1,000 corrosive sublimate. For the disinfection of clothing, bedding, etc., which have become infected with tuberculous sputum, they

1. Mittheil. a. d. Kais. Ges., II., 131. 1884.

recommend subjection to steam for one hour. With steam, fresh, moist sputum is more quickly disinfected than dry sputum. Böiling with water one half hour is certain. In the opinion of Schill and Fischer, sublimate is unsuitable for the disinfection of fresh sputum, but they recommend the use of a 5 per cent. solution of carbolic acid mixed with the sputum, half and half.

Yersin[1] states that a 5 per cent. acid solution of carbolic acid sterilized tuberculous sputum in one half minute, and a 1 per cent. solution in one minute.

Grancher and Gennes[2] sought to determine the most efficient methods for disinfecting tubercular sputum. The chemical agents tested by them were 5 per cent. solutions of carbolic acid, potash, copper sulphate, zinc chlorid, and 1 per cent. solutions of corrosive sublimate. Ten parts of the disinfecting solution were mixed with two parts of sputum and shaken. The efficiency of the sterilization was determined by inoculation into animals. Of the animals thus used all died, either very soon of septicemia, or after some weeks with tuberculosis, with the exception of those which had been inoculated with sputum to which sublimate had been added. None of these latter animals died of septicemia nor of tuberculosis. On account of the poisonous nature of sublimate, the authors did not deem this a suitable disinfectant for general use.

They then proceeded to experiments with heat as the disinfecting agency. The sputum was floated in sterile water, the temperature of which was raised to 60°, 80°, and 100°. That which had been heated to 60° and 80° was not destroyed with certainty, but, on the other hand, that which had been subjected to a temperature of 100° was sterilized without exception. When soda is added to the water in spittoons it facilitates their cleansing when they are disinfected with heat.

For the disinfection of spittoons in hospitals they recommend a small, netallic disinfecting chamber inside of which the spittoons with their contents are placed and into which steam is turned.

Kirschner's[3] conclusions, based upon his own experiments, are that hot water coagulates the sputum and thus sterilization

1. Revue D'Hygiene, XII., 76. 1890.
2. Revue D'Hygiene, X., 193. 1888.
3. Centr. für Bak., IX., 41. 1891.

would not ensue. He has not found that the temperature of 70° C. for ten minutes will destroy the bacillus, as Yersin claims. But he thinks that streaming steam is needed for rendering the sputum harmless. In his hospital he has in operation an apparatus for the disinfection of the sputum in cuspidors something like that advised by Grancher and Gennes. He lets the glasses containing the sputum remain a full half hour in the steam apparatus after the thermometer registers 100° C. Incidentally it may be mentioned that, in his hospital, he has cuspidors for tuberculous patients held on iron supports at the height of about one metre.

The Health Department of the City of New York[1] advises that tuberculous sputum should be received in covered cups containing a 5 per cent. solution of carbolic acid or milk of lime. As regard the use of the latter agent for this purpose, it would be well to bear in mind that Jaeger found that lime-wash is an inefficient disinfectant for the bacillus of tuberculosis.

As the results obtained by most investigators indicate that cresol, lysol, and solutol are generally more rapid and certain in their action than carbolic acid, they probably may well be substituted for carbolic acid. In Buttersack's[2] experiments with the cresols a 10 per cent. solution of two of them sterilized fresh sputum which contained an abundance of bacilli.

There is some doubt as to the applicability of chlorid of lime to the disinfection of tuberculous sputum. The unpleasant and irritating odor is at least objectionable.

Since it has been determined that iodin trichlorid has germicide powers of the highest order, and that this action is but little influenced by the presence of albuminous matter, it is probable that this agent may be found very efficient for the disinfection of fresh sputum. Its irritating vapor, however, bars it from the immediate presence of the patient.

Corrosive sublimate is entirely unsuitable for the disinfection of fresh sputum.

Ascoli states that formaldehyde solution acts efficiently in the disinfection of sputum, but its action, some what like that of sublimate in coagulating albuminous matter, furnishes a good

1. Circular, Disinfection and Disinfectants, 1 Form L, p. 8.
2. Arbeiten a d. Kais. Ges., VIII., 359. 1892.

reason for doubting the adaptability of this agent to this purpose. Further experiments should determine the question.

The experiments of Christmas, Rideal, and Fränkel, stamp phenosalyl as a compound that merits a thorough experimental trial in the disinfection of fresh tuberculous sputum.

Dried Tuberculous Sputum.—In the disinfection of dried tuberculous sputum, or tuberculous dust, some chemical disinfectants may be used which are not suitable for the disinfection of fresh sputum. In the disinfection of a room which has been occupied by a consumptive, the same general rules may be followed which are given under "Rooms," "Walls," and "Floors." All dust should be removed very carefully from furniture, walls, and floors, with a cloth squeezed out of a disinfecting solution,—lysol, 4 per cent.; carbolic acid, 5 per cent.; or mercuric chlorid, 1 : 1,000. If the disinfection of the room is to be completed with the liquid disinfectants, the washing should be repeated, the time intervening between the two washings not necessarily exceeding half an hour. Floors and the cracks in them should be thoroughly treated with the solution.

If the room is to be disinfected with formaldehyde gas, a preliminary spraying or washing with a 2 per cent. solution of formaldehyde (5 per cent. of formalin) of floors and the lower parts of the walls that may have been soiled with expectorations, is advisable.

The clothing and bedding of tuberculous patients are preferably disinfected with steam. (See "Bedding," "Clothing," and "Furniture.")

The rooms of consumptive patients, during their illness, should receive quite frequent disinfections—every two or three weeks—preferably with formaldehyde gas as being the most convenient. When formaldehyde is not available, the infectious dust should be removed with a dampened cloth as already advised.

Tuberculous Milk.—The principal recourse for the sterilization of milk is by heating it. The bacillus of tuberculosis when suspended quite uniformly in a fluid, as in milk, is much more readily destroyed by heat than when in tuberculous sputum, fresh or otherwise. The thermal death-point of the tubercle bacillus in milk is variously stated by different authorities.

Yersin says that the temperature of 75° C. (167° F.) maintained ten minutes, sterilizes milk so far as the bacillus of tuberculosis is concerned.

Bitter[1] concludes that the temperature of 155° F. continued thirty minutes suffices. He found, however, that the whole mass of the milk must be raised to the required temperature, and that those forms of sterilizing apparatus in which the milk flows over heated surfaces, or in which it is delivered in a continuous flow, are not to be trusted.

The investigations of De Man[2] in the laboratory of Professor Forster in the University of Amsterdam, made for the purpose of determining this point, appear to have been careful and extended. That his experiments might approach as nearly as possible the conditions found in the actual process of Pasteurizing milk, the material used was milk demonstrated to be virulent, or milk rendered virulent by the addition to it of secretions from tuberculous udders. After the milk had been brought to the required temperature, it was rapidly cooled by running water which had a temperature of from 10° to 12° C.

His experiments showed him that the tubercle bacillus in tuberculous milk is destroyed

in four hours at the temperature of 55° C.
in one hour at the temperature of 60° C.
in fifteen minutes at the temperature of 65° C.
in ten minutes at the temperature of 70° C.
in five minutes at the temperature of 80° C.
in two minutes at the temperature of 90° C.
in one minute at the temperature of 95° C.

As to the changes which occur in milk during Pasteurization or sterilization, it is generally stated that they begin at 68° C. and that they increase from this point on, with the elevation of the temperature and the duration of its action.

His own experiments with various persons show that the change in taste is rarely detected when the temperature of 70° C. is maintained ten minutes. Only one person out of a considerable number was able to distinguish the Pasteurized milk from the unpasteurized at this temperature. The results of the investigations of De Man coincidewith thoseof Bitter; that those

1. Zeit. für Hygiene, VIII., 255. 1890.
2. Archiv für Hygiene, XVIII., 133. 1893.

processes of Pasteurization in which the milk passes over a heated surface are not trustworthy. The bacilli are not destroyed. To ensure sterilization, the whole bulk of the milk must be brought to the required temperature and maintained at this point for the required length of time. The observations in the Amsterdam laboratory show that many samples of Pasteurized milk upon the market contain many bacteria; some of them as much as a million per cubic centimetre.

At the recently held International Hygienic Congress in Madrid, Lehmann of Würzburg, stated that heating milk or cream to 65° C. for five minutes does not suffice to destroy all the pathogenic bacteria, but it is accomplished by heating it to from 82° to 85° C. for ten minutes.

It appears, therefore, that the temperature of 167° F. (75° C.), continued for twenty minutes, is none too high a requirement for safety, and this is now quite generally accepted as the proper temperature and time for the Pasteurization of milk.

VETERINARY PRACTICE.

The rules of the various cattle commissions and veterinary authorities relating to the disinfection of stalls, cattle cars, etc., are not well defined. In most cases the spaces to be disinfected are too open in their construction to permit any part of the work to be done with gaseous disinfectants. Usually the work must be done wholly with solutions applied with a brush or otherwise. The period of exposure of infectious matter to the disinfectant in its liquid form is necessarily brief, and disinfecting agents whose action is rapid and vigorous should be used.

Jaeger's[1] investigations were more extended than those of any other worker known to me. His work brought out very clearly the necessity of adapting the disinfecting agent to the specific kind of infection to be destroyed. For instance, while brushing the surface with a 1 : 3 milk of chlorid of lime destroyed anthrax spores, it was untrustworthy as a disinfectant for the bacillus of tuberculosis and even for that of glanders. For the destruction of the bacillus of tuberculosis he found carbolic acid and the other coal-tar phenols very efficient, especially when acidulated with hydrochloric acid. For this purpose he recom-

1. Arbeiten a. d. Kais. Ges., V., 247. 1889.

mends especially Laplace's 4 per cent. solution of crude carbolic acid with 2 per cent. of hydrochloric acid. In the hands of Jaeger, the power to destroy anthrax spores with certainty has been shown only by solutions of carbolic acid and the thick chlorid of lime mixture.

It is probable that some of the newer preparations of cresol will be found to be very efficient in veterinary work, particularly solutol and crude solutol, the latter of which is said to be a cheap as well as efficient disinfectant. (See Solutol.)

A thick milk of lime applied once with a brush, Jaeger found efficient in the disinfection of the micro-organisms of chicken cholera, hog cholera, erysipelas of swine, typhoid fever, glanders, anthrax bacilli without spores, and Staphylococcus pyogenes aureus.

Giaxa,[1] in a similar line of work to that of Jaeger's, found that, in the disinfection of walls, even a 5 per cent. lime-wash acting forty-eight hours failed to destroy anthrax spores, the bacillus of tuberculosis, and the bacillus of tetanus.

A strong solution or *brei* of chlorid of lime may be classed as one of the rapidly acting disinfectants for most bacteria, but Jaeger's report of its failure when applied to the infection of tuberculosis and glanders should be borne in mind. For the cleansing of cattle cars, Gruber[2] advises scrubbing them out with hot water or washing with a 2 per cent. solution of soda at 50° C., although this has no particular disinfecting power. If the cars are infected; he sprays with a 5 to 10 per cent. solution of formaldehyde.

For the disinfection of railway cars, etc., in connection with outbreaks of foot-and-mouth disease and other diseases of animals, J. Peters[3] recommends the plentiful use of milk of lime.

For the disinfection of cattle, Reuter[4] recommends a pool of solution of lysol 25-30 centimetres deep into which to drive cattle with foot-and-mouth disease.

1. Giornale della Reale Soc. Ital. D'Ig., XII., 345. 1890.
2. Deutsche Viert. für öff. Ges., XXVIII. (Suppl.), 257. 1897.
3. Berliner Thierärztliche Woch., 1893, p. 377.
4. Hyg. Rundschau, II., 685. 1892.

WALLS.

Esmarch[1] disinfected the walls of rooms in various ways and tested the results bacteriologically. When the walls were rubbed twice with sponge saturated with 1 : 1,000 corrosive sublimate solution, or with a 2 per cent. or a 5 per cent. carbolic acid solution, complete sterilization of the limited surface examined occurred five times out of twelve. Esmarch believes that the mechanical action of the sponge is the main factor in the removal of the bacteria from the walls. Experiments were also made by spraying, which was found rarely to injure the walls. He found, however, that rubbing the walls down carefully with bread left them entirely free, or almost wholly free from germs. The tables which he presents, giving the results of his various experiments, were so conclusive that this method of sterilizing the walls of infected rooms has been in general use for some years past in Germany, and in other countries. Rye bread is used for rubbing the walls, and it should be quite freshly baked, not more than twenty-four hours old. It is cut in junks of a suitable size to be grasped in the hand, and the wall is rubbed with the cut, inner surface of the bread. In most parts of this country, however, it would be somewhat difficult to obtain bread possessing the requisite degree of porosity and adhesiveness. This method is used principally for rubbing down papered walls.

Esmarch says that generally the germs adhere very loosely to the walls; that the walls of the average room of common size have a little less than 1,000,000 germs consisting of bacteria and moulds. He cautions against the removal of paper of infected rooms in the dry way. In disinfecting walls with steam, the steam jet blows away many germs before the heat can destroy them.

Merke,[2] of Berlin, admits that the method of removing disease germs from walls by rubbing with bread is superior to that of spraying with corrosive sublimate, as was suggested by him and Guttmann.

In a paper by Cronberg,[3] on the disinfection of the walls of rooms, he refers to the use of sulphur fumigation, and of chlorin

1. Zeit. für Hygiene, II., 491. 1887.
2. Deutsche Viert. für öff. Ges., XXIII., 259, 274. 1891.
3. Arch. für Hygiene, XIII., 294. 1891.

and bromin gases as not being trustworthy, and especially to the serious injury which results from the use of chlorin and bromin. Cronberg's method of disinfection with sublimate vapor has been shown to be untrustworthy and not without danger. He refers to Guttmann and Merke's method of spraying with a 1 : 1,000 solution of corrosive sublimate, as effective, cheap, and easily applied. The sublimate does not injury the walls, and is not dangerous to the operator or the inhabitants of the room.

Experiments were made by Cronberg in disinfecting the walls of rooms by rubbing them with sponge, with spunk, with wash-leather, and with rubber. The walls were of different kinds, papered, painted, and whitewashed. The micro-organisms used were Staphylococcus pyogenes aureus, and tuberculous sputum. Only a few experiments were made with rubber and with bread. The experiments with spunk, rubber, and wash-leather did not give favorable results.

Of nine walls rubbed with sponge dipped in sterilized water, four were rendered completely sterile.

Of five experiments with bread, in no case was complete sterilization accomplished. Bread has the disadvantage of crumbling, and of injuring the walls sometimes by adhering to their surfaces.

Disinfection with sponge gave the best results. It was easily handled and did not crumble as bread does. The author believes that better results might be obtained by washing the sponge in an acidified solution of corrosive sublimate 1 : 1,000, and squeezing it out before using it. One experiment was made in this way and the wall was found completely sterile.

Experiments were made by Lapasset[1] for determining the efficiency of various methods of disinfecting walls. Their disinfection with bread, besides being costly and requiring much manual labor, gave results comparatively unsatisfactory. Cleansing the walls with a damp sponge which had been sterilized by boiling for twenty minutes did not give satisfactory results. Dampening the walls with a solution of corrosive sublimate 1 : 1,000 and 1 : 500 was not satisfactory. To destroy with certainty the germs upon the walls, corrosive sublimate 5 : 1,000 is

1. Revue D'Hygiene, XIV., 481. 1892.

required. The solutions of sublimate used contained 1 per cent. of muriatic acid.

The application of milk of lime gave more satisfactory results as regards sterilization of the walls than any other process employed, not only as regards the superficial dust, but the liquid appeared to penetrate the subjacent particles of the wall. The milk of lime used was prepared by slaking two kilograms of freshly burned lime in ten litres of water, decanting the upper portion in about a quarter of an hour so that all particles of solid matter, excepting that which is suspended in an exteremely fine condition, are left behind. His experiments further showed that the ordinary whitewash, often made with the addition of chalk, whiting, or matter other than caustic lime, was not efficient as a disinfectant.

In the investigations of Gerlach[1] into this subject, the results were unsatisfactory in only two instances out of forty, when a 3 per cent. solution of lysol was used as a spray.

In Paris the official process of disinfecting the walls of rooms is spraying with a 1 : 1,000 solution of corrosive sublimate. The special spray apparatus used in this work throws a fine but dense spray, so that the walls are quickly wetted. The results are said to be very satisfactory as indicated by the present, as compared with the former statistics of recurring cases.

The need of the disinfection of the walls of sick-rooms is more urgent in connection with some diseases than with others. In typhoid fever, the possibility of their infection is but very slight. In diphtheria, scarlet fever, and pulmonary tuberculosis we have to deal with the probability of their infection, through the ejection of infectious sputa, and by the floating in the atmosphere of infectious dust or liquid particles.[2] In these cases efficient methods of disinfection are required. In recent practice, formaldehyde gas is trusted to disinfect the wall surfaces, and this is undoubtedly safe, provided the room is of tolerably tight construction. When, however, there is any probability of the walls having been smeared with infectious matter, as often occurs in severe cases of diphtheria or in the last days of pulmonary tuberculosis, they should be washed or sprayed with a 2 per cent. solution of formalin before the formaldehyde generator is set at work.

1. Deutsche Viert. für öff. Ges., XXIII., 148. 1891.
2. See Flügge, Zeit. für Hygiene, XXV., 179. 1897.

The walls of rooms of loose construction, as in the dwelling-houses of some of the poorer classes, can be disinfected efficiently only by scrubbing them in a disinfecting solution as of corrosive sublimate, carbolic acid, lysol, solutol, or cresol.

WATER.

These notes do not relate to the purification of permanent municipal supplies, but to its treatment, on a small scale, or in connection with military or naval service. Polluted and, therefore, presumably infected waters, may be freed from infectious mattter by chemical treatment, or by physical or mechanical agencies. The use of the latter is largely restricted by the exigencies of the march or of camp life.

Bromin.—Dr. Schumburg,[1] a German military surgeon, finds that a small quantity of bromin added to polluted water destroys all pathogenic bacteria, and nearly all water-bacteria, in five minutes, and that after this period of time, neutralization of the bromin with ammonia leaves a clear, tasteless, drinking water. He uses a solution consisting of 20 parts potassium bromid and 20 of bromin in 100 parts of water. Of this solution 0.2 cc. suffices for the sterilization of one litre of water. The same quantity of a 9 per cent. solution of ammonia is required for the neutralization of the bromin which remains in excess. If the water is very hard, or badly polluted, the bromin should be added until the water retains a slightly yellowish color about half a minute. A corresponding increase in the quantity of ammonia is then required. This process, in addition to being efficient, is an economical one, he says; for one kilogram of bromin costing five marks (about $1.25) will sterilize 16,000 litres of water.

In a later communication[2] he states that, to 20 grams of potassium bromid and 21.91 grams of free bromin, enough water should be added to bring the weight of the solution up to 100 grams. For the neutralizing of the free bromin in the water, he now uses tablets each of which contains:

Sodium sulphite	0.05
Sodium carbonate, dried	0.04
Mannit	0.025

Each tablet suffices for one litre of water.

1. Deutsche Med. Woch., XXIII., 145. 1897.
2. Ibid., p. 407.

Chlorid of Lime.—According to Traube,[1] water which is heavily laden with bacteria is sterilized in two hours by the addition of chlorid of lime at the rate of 0.00426 gram of chlorid of lime (equivalent to 0.001065 gram of chlorin) per one litre of water. For the neutralization of the excess of chlorin left in the water, the addition of 0.00209 gram of sodium sulphite suffices. An excess of sodium sulphite to the extent of 50 per cent. does no harm.

Bassenge[2] sought to determine whether the sterilization of water with chlorid of lime is practicable. His conclusions are:

That the addition of 0.0978 gram of active chlorin per litre of water, or 0.15 gram of commercial chlorid of lime per litre, sterilizes water in ten minutes, which is badly infected with pathogenic bacteria: with the extension of the time to two hours, 0.0108 gram of chlorin suffices.

That the excess of chlorin not used up in its disinfecting work can be neutralized with calcium sulphite, a precipitate of sulphate of lime falling. Water thus treated has no unpleasant taste, and its continued use is not injurious.

That no chemical evidence is needed when the excess of chlorin is neutralized, for its presence is readily detected by its taste and odor. That this is a certain process for sterilizing water, that it is simple and convenient, and that it is of great practical significance.

Bassenge says that instead of using it in solution, chlorid of lime in powder may be added from the point of a knife, and after shaking vigorously and waiting ten or fifteen minutes, a solution of calcium bisulphite may be added, drop by drop, until the taste and odor of chlorin disappears.

The interesting question opened by Traube was also taken up by Dr. Lode[3] in the Hygienic Institute of the University of Vienna, and he determined that the quantity of chlorin prescribed by Traube, about 0.001 gram per litre of water is insufficient. The quantity of available chlorin must be about thirty times that stated by Traube, or three milligrams per litre to destroy all sporeless bacteria. The destruction of all sporing organisms is an ideal requirement, but it is unnecessary and is impracticable with chemical agents.

1. Zeit. für Hygiene, XVI., 149. 1894.
2. Zeit. für Hygiene, XX., 227. 1895.
3. Archiv für Hygiene, XXIV., 236. 1895.

The method which Lode recommends for use in the field is to add to, say ten or twenty litres of water, the requisite quantity of chlorid of lime which has been rubbed up with a small quantity of water in a spoon or something else. When it is not previously wet up, a large part of the chlorin remains undissolved. It should then be added to the larger quantity of water; or the chlorin can be made immediately available by adding a small quantity of citric acid to the chlorid of lime, wet up with water in a mixing spoon and stirring it at once into the water. After ten minutes the appropriate quantity of sodium sulphite or calcium sulphite can be added. Then the water should be passed through a rapid filter, flannel, if nothing better is at hand.

Permanganates.—The use of the permanganates for the purification of water is a time-honored recommendation. These agents, however, do not exert so rapid a disinfecting action as some others, and there seems to be reason to doubt whether the permanganate treatment alone is trustworthy. The rule for using potassium permanganate is to add a solution of it, little by little, stirring the water meanwhile, until a faint, pale pink tint persists some time, finally disappearing.

Mille. Schipiloff, of the University of Geneva, recommends the addition, to suspicious water, of permanganate of sodium, or potassium, until the pink color of the water persists an hour, then, if necessary, the addition of a small quantity of sugar to transform the slight excess of permanganate into oxid of manganese.[1]

Bordas and Girard find that permanganate of calcium is very efficient in the sterilization of water. (See Permanganates.)

Hydrogen Peroxid.—The experiments of Van Tromp indicated that, ordinarily, 1 part of hydrogen peroxid to 10,000 of water insures its sterilization in twenty-four hours. Uffelmann's investigations and those of Altehofer, however, did not show so good results with hydrogen peroxid. Those of the latter convinced him that water containing many typhoid fever germs cannot be sterilized, in twenty-four hours, with a smaller proportion than 1 : 1,000. (See Hydrogen Peroxid.)

Various Methods.—In the Bacteriological Institute of Bucharest, V. and A. Babes[2] investigated the various methods of

1. Revue D'Hygiene, XV., 749. 1893.
2. Centr. für Bak., XII., 132. 1892.

purifying water. The action of filters was found to be uncertain. By the addition of alum, or the simultaneous addition of pulverized chalk and sulphuric acid, or chalk and sulphate of iron, surprisingly good results were obtained. The addition of 0.15 gram of alum to a litre of water rendered it almost free from bacteria in twelve hours, and it remained so four days. The best results were obtained by adding six grams of pulverized chalk and 0.98 gram of sulphuric acid to two litres of water, or 0.25 gram sulphate of iron and 0.25 gram of chalk to one litre of water. When pulverized chalk and sulphuric acid are added simultaneously, the resulting precipitate of sulphate of lime clarifies, and almost completely sterilizes the water, and it is left charged with the refreshing carbonic acid gas.

A method of sterilizing water advocated by Prof. Agrégé at the Val-de-Grâce Military School, consists in adding a powder composed of quicklime, 9 parts; carbonate of sodium, 5 parts; powdered alum, 1 part; powdered sulphate of iron, 1 part. As a rule, from 30 to 50 centigrams will sterilize one litre of water. The powder is added over night and the water is decanted in the morning.[1]

As stated by Stevenson and Murphy in their chapter on Military Hygiene:[2]

"The purification of water is important on service, when almost any supply has to be made available at times. In many instances no filters are at hand, and means have to be taken to make the water usable. If it is turbid from finely divided silt, this may be got rid of by the addition of alum in the proportion of six grains to the gallon of water. This plan acts well if there is any calcium carbonate present in the water; if this is absent, it is advisable to add a little sodic carbonate first to the water before treating it with alum. The water is then allowed to rest, and in a short time will be found to have deposited the greater part of the suspended matters; it may then be filtered and boiled.

"In the Ashanti campaign of 1873 the following plan was adopted by Dr. Gouldsbury in the absence of proper filters. Alum was added to precipitate organic matter, the water was then passed through a rough filter, consisting of (1) sponge,

1. Lancet II, 1892, 807.
2. Treatise on Hygiene, II., 628. 1893.

(2) sand, (3) charcoal in pieces; it was then boiled, and a few drops of solution of potassium permanganate added. Water even taken from a hole in a marsh was innocuous after this treatment.

"In the Egyptian campaign, wells were dug in close proximity to the fresh-water canal, so as to allow filtration through the soil. The water percolating through was collected and alum added; it was subsequently filtered and boiled."

Filters.—Almost all of the portable filters have been shown to be incapable of removing the dangerous contents of an infected water. Improvised filters are, however, often of much use in removing the coarser part of the suspended organic matter of polluted waters, and thus facilitating their purification by oxidizing chemical agents, like the permanganates or chlorid of lime. Their use after chemical treatment is often required for the removal of the resulting precipitate.

A report by Dr. Plagge to the Prussian War Office, mentions that, in 1885, he tested all the known filters, and found that the carbon, natural stone, gravel, sand, cloth, sponge, paper, spongy iron, and asbestos forms were entirely useless. In a later investigation he found the same results. The Pasteur-Chamberland filter, however, was described as satisfying all sanitary requirements. The Berkefeld, an imitation of the Pasteur filter, gave less satisfying results. Twenty-nine out of thirty-seven specimens of these filters passed microbes almost immediately, within twenty-four hours, or before the end of their trials. The Berkefeld filter is also more fragile than the Pasteur-Chamberland form.

Mr. Hankin, official chemist and bacteriologist to the Northwest Provinces of India, maintains, in his report of 1895, that all the domestic filters, with the exception of the Pasteur-Chamberland, are quite incapable of keeping back the cholera bacillus.[1]

To the use of the Pasteur filter by the French army during recent years is attributed the great decrease in the mortality from typhoid fever amongst the soldiers (50 per cent.). In a series of experiments made by Dr. Johnson, bacteria were found in the water passing through a Berkefeld filter within three to ten

1. Rideal. Water and Its Purification, p. 177. 1897. London.

days of continuous use. The Pasteur filtrate remained sterile for six weeks. Recent experiments made by Dr. Sims Woodhead confirm the superiority of the Pasteur filter.[1]

Heat.—After reviewing other methods of sterilizing infected water, it may probably be said that the only absolutely certain way is the application of heat. Merely raising the temperature of a tolerably clear water to the boiling point, suffices to destroy with certainty the pathogenic organisms of malarial faver, typhoid fever, dysentery, and cholera, and probably the germ of yellow fever, if that should be present in the water. Water thus treated may be made more palatable by the aeration which it receives in passing through a filter after it has been boiled.

In Europe, several kinds of apparatus have been devised for the sterilization of water with heat. In some of these the heat of the water that is just sterilized is utilized in raising the temperature of the incoming water, and is itself cooled by the same process and delivered with a temperature only slightly above that of the water of the original source.

WATER-CLOSETS.

After infectious diseases the bowls of water-closets may be disinfected by washing them with a solution of lysol, solutol, or carbolic acid (Solution 2, 3, or 1 of the State Board of Health of Maine). The regulations of the City of Paris prescribe a solution of sulphate of copper for this purpose. For the woodwork, and the floors of bathrooms, a 5 per cent. solution of formalin (2 per cent. formaldehyde gas) or the carbolic acid solution may be used, or the lysol or solutol solution if the character of the wood finish makes them applicable.

WATER MAINS.

During the serious epidemic of typhoid fever in Maidstone, England, in 1897, Dr. Sims Woodhead dissolved chlorid of lime in the reservoir at the rate of about one ton to 24,000 gallons of water, and allowed the solution to flow into the mains. At a certain hour it was turned into all the house connection in the district.

1. Thresh. Water Supplies, p. 249. 1896. London,

Instead of calcium hypochlorite, the active part of chlorid of lime, the disinfection of water pipes might be accomplished with sodium hypochlorite manufactured through the agency of the electric current. It would be merely a question of comparative cost between electrolysis and the older methods of manufacture.

WELLS.

The success of attempts to disinfect wells which were dug and stoned in the ordinary ways, should probably be considered as very uncertain. As the infection has almost invariably come from the ground in which the well was sunk, the problem is a farther reaching one than the disinfection of the well itself. The former eminent secretary of the Maryland State Board of Health, Dr. Chancellor,[1] recommends "throwing into the well from ten to twenty pounds of chlorid of lime, according to the size of the well and the depth of the water in it. When such disinfection has taken place, and within two or three days thereafter, the well must be completely cleaned, and then within two or three days thereafter disinfected anew, by throwing into it ten or twenty pounds more of the lime, and subsequently, after a couple of days, pumping out all the water."

Fränkel[2] found that tubular wells may be disinfected, but that ordinary wells cannot be permanently disinfected for the reason that they are reinfected from the ground. Neisser's[3] experiments with chemical agents led to the same conclusions, but convinced him that wells of the ordinary kind can be disinfected with the steam from a portable engine conducted into the water of the well until it is hot. But his experiments were made with a well which was purposely infected through its open mouth, instead of through the ground as is usually the case.

For the disinfection of wells in the North-Western Provinces of India, Mr. Hankin recommends permanganate of potassium used as follows:

"A sufficient quantity of the solid potassium permanganate is to be added to give the water of the well a faint pink color that lasts for at least twelve hours. One ounce of the substance will

1. Ninth Biennial Report, page 75. 1891.
2. Zeit. für Hygiene, VI., 23. 1889.
3. Zeit. für Hygiene, XX., 301. 1895.

be sufficient for an ordinary-sized clean well. This should be put into a *dol* or bucket, lowered into the well, hauled up, the water poured back into the well, leaving the residue of undissolved permanganate at the bottom of the bucket. The process should be repeated till all the permanganate has been dissolved. Half an hour after adding the permanganate a specimen of the water should be drawn up and inspected. If a red color is still present, enough has been added. If the red color has vanished, as may be the case if the well is dirty, a further quantity of permanganate should be added. The well should be again opened for use on the following day."[1]

Saprol has been used successfully in determining the source of pollution of wells, or whether polluted from a suspected source, by pouring it into the suspected source of pollution and noting whether the well water acquires the taste and odor of saprol. Another recommendation is to pour into the privy vault or other suspected source of pollution about a pint of fluorescin—eight ounces to one and one half pints of water. In a short time, if contamination exists, the well water will be colored a deep red.

XEROFORM.

Dr. C. G. Crumston,[2] of Boston, says that of all the groups of antiseptics, bismuthum tribromphenylicum, or, as it is also termed, xeroform, is recognized as the most active. First, because it contains, besides 49 per cent. of oxid of bismuth, 50 per cent. of tribromophenol, while other products contain from 10 to 20 per cent. of phenol, cresol, or naphthol; and second, tribromophenol is more antiseptic than phenol.

From his experiments in the use of xeroform, he strongly recommends this substance to the profession as a safe and sure antiseptic, and in many respects superior to iodoform, or other powders of this class.

As a result of his investigation of the value of xeroform as an antiseptic, Heuss,[3] of Zurich, was able to report that xeroform is not poisonous; that it is almost completely odorless and tasteless; that it is entirely non-irritating even to diseased

1. The Indian Lancet, VI., 375. 1895.
2. Boston Med. and Surg. Jr., CXXXVI., 37. 1897.
3. Therapeutische Monatshefte, X., 214. 1896.

mucous membranes; that it has a powerful antiseptic action; and that it is well adapted as an intestinal antiseptic and in the treatment of wounds. In the treatment of wounds it favors epithelial growth and alleviates pain. On account of the lightness of the powder, a smaller volume than that of iodoform suffices to cover surfaces. He thinks that he is justified in asserting that in xeroform we possess an antiseptic which stands next to iodoform, and that in some respects it has marked advantages over iodoform.

ZINC CHLORID.

In Koch's[1] experiments, a 1 per cent. solution of chlorid of zinc failed to kill Micrococcus prodigiosus in forty-eight hours, and a 5 per cent. solution had no effect upon anthrax spores in thirty days. Neither was there evidence of marked inhibitive action.

In Sternberg's[2] hands, a 2 per cent. solution of chlorid of zinc was destructive of the micrococcus of gonorrheal pus, while 0.5 per cent. destroyed the septic micrococcus. In later experiments anthrax spores were not killed in two hours with a 10 per cent. solution, but a 5 per cent. solution sterilized putrid beef-peptone solution which included Bacillus subtilis.

Applied to the disinfection of excreta, Vincent[3] learned that chlorid of zinc causes a temporary decrease in the number of germs, but after twelve or twenty hours there is an increase in their numbers, and they are plentiful in forty-eight hours. It is a very good deodorant, he says, but a very inefficient disinfectant for fecal matter.

ZINC SULPHATE.

The experiments of Koch, Sternberg, and others show that this salt has no practical value as a disinfectant, and but very slight value as an antiseptic. Pane,[4] experimenting with a 5 per cent. solution, found that staphylococcus on threads, even when exposed to the solution one hour at the temperature of 30° C., was unaffected by its action save a slight retardation in the development of the bacteria.

1. Mittheil. a. d. Kais. Ges., I., 261. 1881.
2. Am. Jr. M. Sc. Apr. 1883. p. 331.
3. Annales de l'Inst. Past., IX., 10, 1895.
4. An. dell' Istituto D'Ig. Sperimentale dell' Univ. di Roma, II., 96. 1890.

INDEX.